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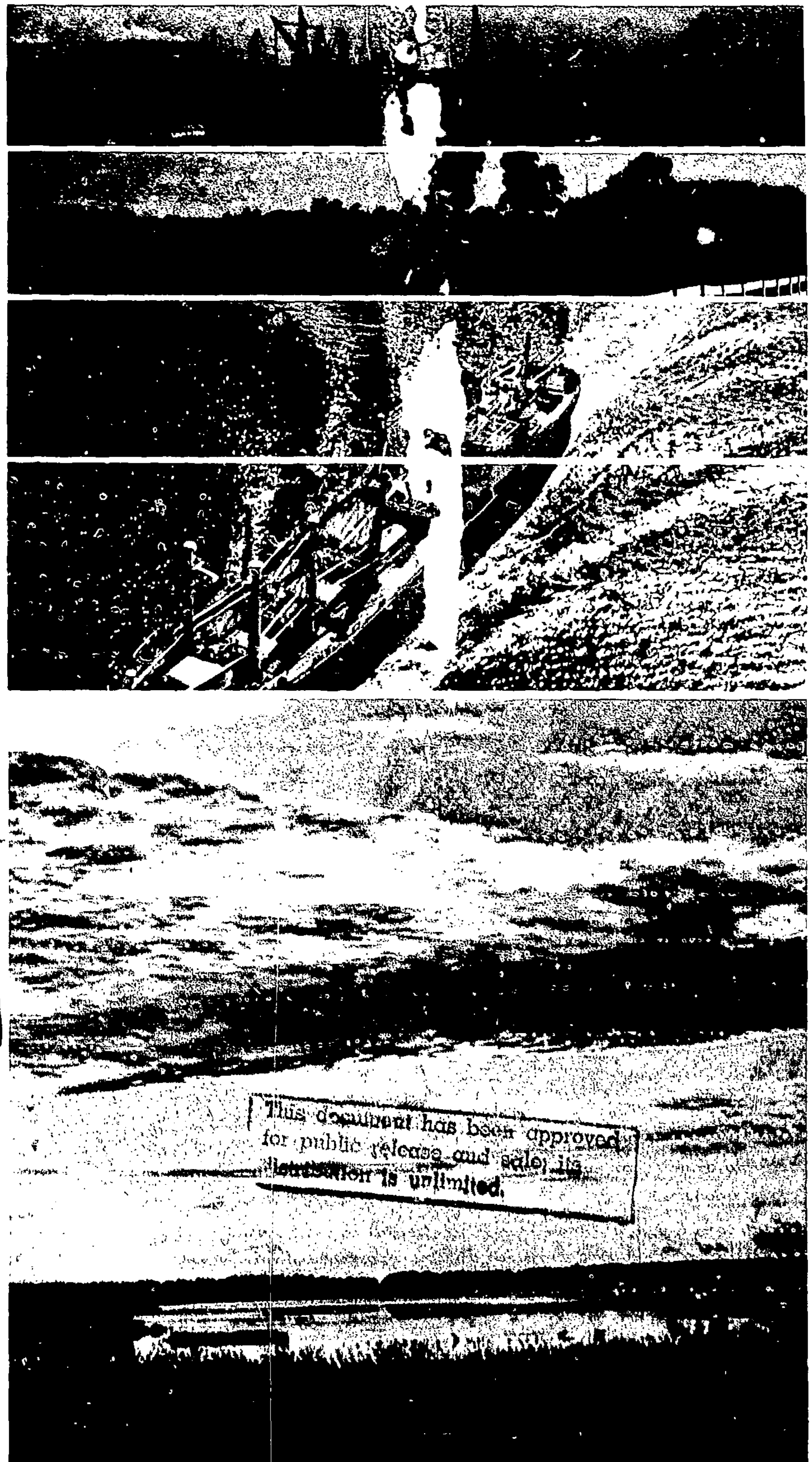
VOLUME 6
Water Quality



Chesapeake Bay
FUTURE CONDITIONS REPORT

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: (14) FCR-77-006

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): (6) Chesapeake Bay Future Conditions Report. Volume VI. Water Quality.

5. TYPE OF REPORT & PERIOD COVERED: (9) INTERIM rept.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Baltimore District
U.S. Army Corps of Engineers
Box 1715, Baltimore, Maryland 21203

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

Baltimore District
U.S. Army Corps of Engineers
Box 1715, Baltimore, Maryland 21203

12. REPORT DATE: (11) Dec[redacted] 1977

13. NUMBER OF PAGES: 235

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (12) 250p.

15. SECURITY CLASS. (of this report)

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE

Volume VI of 12 Volumes

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Water Quality Standards	BOD
Chesapeake Bay Region	Eutrophication
Municipal Wastewater Flows	Dissolved Oxygen

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

See Preface

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PREFACE

The Corps of Engineers' comprehensive study of Chesapeake Bay is being accomplished in three distinct developmental stages or phases. Each of these phases is responsive to one of the following stated objectives of the study program.

1. To assess the existing physical, chemical, biological, economic and environmental conditions of Chesapeake Bay and its related land resources.

2. To project the future water resources needs of Chesapeake Bay to the year 2020.

3. To formulate and recommend solutions to priority problems using the Chesapeake Bay Hydraulic Model.

In response to the first objective of the study, the initial or inventory phase of the program was completed in 1973 and the findings were published in a document titled *Chesapeake Bay Existing Conditions Report*. Included in this seven-volume report is a description of the existing physical, economic, social, biological and environmental conditions of Chesapeake Bay. This was the first published report that presented a comprehensive survey of the entire Bay Region and treated the Chesapeake Bay as a single entity. Most importantly, the report contains the historical records and basic data required to project the future demands on the Bay and to assess the ability of the resource to meet those demands.

In response to the second objective of the study, the findings of the second or future projections phase of the program are provided in this the *Chesapeake Bay Future Conditions Report*. The primary focus of this report is the projection of water resources needs to the year 2020 and the identification of the problems and conflicts which would result from the unrestrained growth and use of the Bay's resources. This report, therefore, provides the basic information necessary to proceed into the next or plan formulation phase of the program. It should be emphasized that, by design, this report addresses only the water resources related needs and problems. No attempt has been made to identify or analyze solutions to specific problems. Solutions to priority problems will be evaluated in the third phase of the program and the findings will be published in subsequent reports.

The *Chesapeake Bay Future Conditions Report* consists of a summary document and 16 supporting appendices. Appendices 1 and 2 are general background documents containing information describing the history and

conduct of the study and the manner in which the study was coordinated with the various Federal and State agencies, scientific institutions and the public. Appendices 3 through 15 each contain information on specific water and related land resource uses to include an inventory of the present status and expected future needs and problems. Appendix 16 focuses on the formulation of the initial testing program for the Chesapeake Bay Hydraulic Model. Included in this appendix is a description of the hydraulic model, a list of problems considered for inclusion in the initial testing program and a detailed description of the selected first year model studies program.

The published volumes of the *Chesapeake Bay Future Conditions Report* include:

Volune Number	Appendix Number and Title
1	Summary Report
2	1 – Study Organization, Coordination and History
	2 – Public Participation and Information
3	3 – Economic and Social Profile
4	4 – Water-Related Land Resources
5	5 – Municipal and Industrial Water Supply
	6 – Agricultural Water Supply
6	7 – Water Quality
7	8 – Recreation
8	9 – Navigation
	10 – Flood Control
	11 – Shoreline Erosion
9	12 – Fish and Wildlife
10	13 – Power
	14 – Noxious Weeds
11	15 – Biota
12	16 – Hydraulic Model Testing

CHESAPEAKE BAY
FUTURE CONDITIONS REPORT
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WATER QUALITY

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CHAPTER I

THE STUDY AND THE REPORT

The Chesapeake Bay Study developed through the need for a complete and comprehensive investigation of the use and control of the water resources of the Bay Area. In the first phase of the Study, the existing physical, biological, economic, social, and environmental conditions and problem areas were identified and presented in the *Existing Conditions Report*. The *Future Conditions Report*, of which this appendix is a part, presents the findings of the second or projections phase of the Study. Included as a part of this second phase are: projections of future water resource needs and problem areas, general means that might best be used to satisfy those needs, and recommendations for future studies and hydraulic model testing. Consequently, this Report constitutes the next step toward the goal of developing a comprehensive water resource management program for Chesapeake Bay.

Chesapeake Bay serves as a vast natural asset to the surrounding land area. Along with its tributaries, the Bay provides a natural transportation network on which the economic development of the region has been based, a wide variety of water-oriented recreational opportunities, a source of water supply for both municipalities and industries, and the site for final disposal of our waste products. All of the resources provided by the Bay interact with each other in forming the Chesapeake Bay Ecosystem. Unfortunately, problems often arise when man's intended use of one resource conflicts with either the environment or with his use of another resource.

Although the importance of clean water may vary for each intended use, there is little question that the quality of our water should be preserved. Degraded water has little to offer any of the inter-related uses of the Bay. Compounding the problem are anticipated increases in: population and urbanization, the complex composition of industrial and domestic wastes, thermal cooling wastes, solid waste disposal techniques, and possible synergistic relationships of our waste products. These are all major factors affecting the quality of water in the Bay, each requiring careful management in order that the quality of the Bay's water may be preserved or enhanced.

This ~~particular~~ volume~~, Water Quality,~~ focuses on the quality of the Bay's water resource and the impacts other resources uses have had and will continue to make upon it. This appendix provides an assessment of existing conditions, identifies water quality problem areas and cites the Federal and State agencies currently responsible for management of the Bay's water quality conditions. Based on projections of sewered populations and waste loadings developed by the various State agencies throughout the Bay Area, future needs and problem areas were then developed. Lastly, the means that over

might best be used to satisfy the projected water quality needs and recommendations for future water quality studies are identified.

AUTHORITY

The authority for the Chesapeake Bay Study and the construction of the hydraulic model is contained in Section 312 of the River and Harbor Act of 1965, adopted 27 October 1965, which reads as follows:

> (a) The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to make a complete investigation and study of water utilization and control of the Chesapeake Bay Basin, including the waters of the Baltimore Harbor and including, but not limited to, the following: navigation, fisheries, flood control, control of noxious weeds, water pollution, water quality control, beach erosion, and recreation. In order to carry out the purposes of this section, the Secretary, acting through the Chief of Engineers, shall construct, operate, and maintain in the State of Maryland a hydraulic model of the Chesapeake Bay Basin and associated technical center. Such model and center may be utilized, subject to such terms and conditions as the Secretary deems necessary, by any department, agency, or instrumentality of the Federal Government or of the States of Maryland, Virginia, and Pennsylvania, in connection with any research, investigation, or study being carried on by them of any aspect of the Chesapeake Bay Basin. The study authorized by this section shall be given priority.
>
> (b) There is authorized to be appropriated not to exceed $6,000,000 to carry out this section.

An additional appropriation for the Study was provided in Section 3 of the River Basin Monetary Authorization Act of 1970, adopted 19 June 1970, which reads as follows:

> In addition to the previous authorization, the completion of the Chesapeake Bay Basin Comprehensive Study, Maryland, Virginia, and Pennsylvania, authorized by the River and Harbor Act of 1965 is hereby authorized at an estimated cost of $9,000,000.

As a result of Tropical Storm Agnes, which caused extensive damage in Chesapeake Bay, Public Law 92-607, the Supplemental Appropriation Act of

1973, signed by the President on 31 October 1972, included $275,000 for additional studies of the impact of the storm on Chesapeake Bay.

PURPOSE

Previously, measures taken to utilize and control the water and land related resources of the Chesapeake Bay Basin have generally been toward solving individual problems. The Chesapeake Bay Study provides a comprehensive study of the entire Bay Area in order that the most beneficial use be made of the water-related resources. The major objectives of the Study are to:

a. Assess the existing physical, chemical, biological, economic, and environmental conditions of Chesapeake Bay and its water resources.

b. Project the future water resources needs of Chesapeake Bay to the year 2020.

c. Formulate and recommend solutions to priority problems using the Chesapeake Bay Hydraulic Model.

The *Chesapeake Bay Existing Conditions Report*, published in 1973, met the first objective of the Study by presenting a detailed inventory of the Chesapeake Bay and its water resources. Divided into a summary and four supporting appendixes, the Report presented an overview of the Bay Area and the economy; a survey of the Bay's land resource and its use; and a description of the Bay's life forms and hydrodynamics.

The purpose of the *Future Conditions Report* is to provide a format for presenting the findings of the 2nd phase of the Chesapeake Bay Study. The Report describes the present use of the resource, presents the demands to be placed on the resource to the year 2020, assesses the ability of the resource to meet future demands, and identifies additional studies required to develop a management plan for Chesapeake Bay.

The purpose of this appendix is to present the findings of the Chesapeake Bay Study as they relate to the quality of the Bay's waters. Potential projected waste loadings accompanied by the desired water quality standards for each subregion are presented to provide a focus upon potential water quality problem areas and thus identify areas requiring further study.

SCOPE

The scope of the Chesapeake Bay Study and *Future Conditions Report* includes the multi-disciplinary fields of engineering and the social, physical, and biological sciences. The Study is being coordinated with all Federal,

State, and local agencies having an interest in Chesapeake Bay. For each resource category presented in the *Future Conditions Report*, project demands and potential problem areas are projected to the year 2020. All conclusions are based on historical information supplied by the preparing agencies having expertise in that field. In addition, the basic assumptions and methodologies are discussed quantatively in the sensitivity section. Only general means to satisfy the projected resource needs are presented, as specific recommendations are beyond the scope of the Study.

This appendix is essentially a continuation of the *Existing Conditions Report* on Water Quality, which inventoried the 1970 conditions. However, the passage of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) provided for the accomplishment at the State and local levels much of the water quality work originally envisioned as part of the Chesapeake Bay Study. In order to avoid duplication of effort, the scope of the work for this appendix was revised to integrate into the Chesapeake Bay Study Program the ongoing State and local work concerning water quality in the Bay Area.

Therefore, the responsibility for detailed water quality studies is not provided for in the Chesapeake Bay Study Program and is beyond the scope of this Report. State Water Quality Management Plans, required by Section 303(e) of the Federal Water Pollution Control Act Amendments of 1972, provided projections of wastewater loadings and water quality needs for each river basin to the year 2020. Problem area information was provided through the State Water Quality Inventories, required by Section 305(b) of P.L. 92-500. General means that might best satisfy future water quality problems along with recommended hydraulic model studies are also included in this appendix.

The geographical area considered for the water quality studies in this appendix was based on the river basins which drain the Bay Area's waters. Within the Chesapeake Bay Area, the 18 separate river basin segments as designated by the States of Maryland, Virginia, and Delaware were combined to form six regional study areas. These areas are presented in Figure 7-1. Study sub-areas were formed from the State designated river basins and combined solely for the purpose of eliminating an excessive number of major study areas. A complete listing of the Chesapeake Bay Water Quality Study Areas and the major river basins within each is presented in Table 7-1.

SUPPORTING STUDIES

This Report was coordinated and prepared by the Baltimore District Office, U.S. Army Corps of Engineers. Much of the input to this appendix, however, was developed through other sources. As previously mentioned, State Water

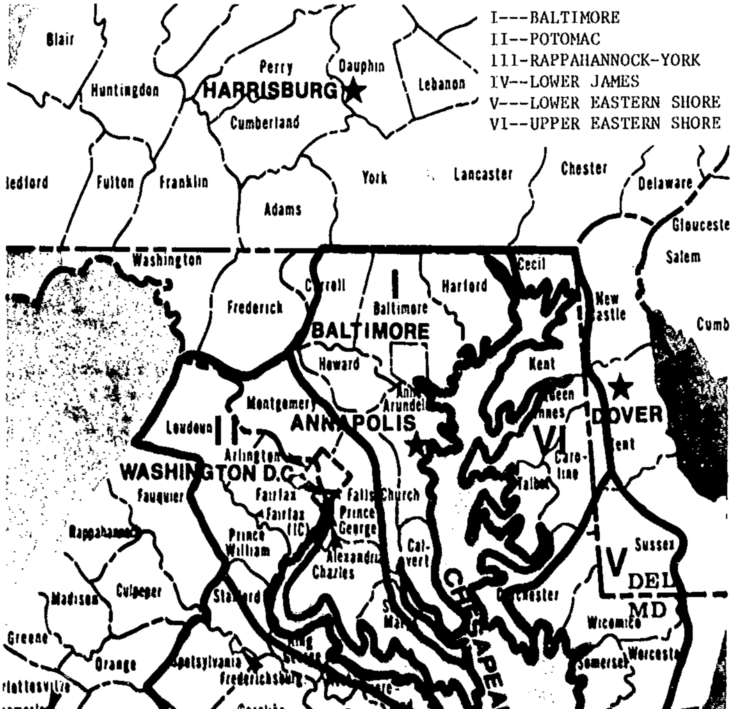


Figure 7-1: The Chesapeake Bay Study Area

TABLE 7-1
CHESAPEAKE BAY STUDY
COMPOSITION OF STUDY AREAS

STUDY AREA I – BALTIMORE

Maryland

Sub-Area B-1 (Upper Western Shore)

- Lower Susquehanna River
- Bush River
- Gunpowder River

Sub-Area B-2 (Patapsco-Back River)

- Patapsco River

Sub-Area B-3 (Patuxent-West Chesapeake)

- Patuxent River
- Magothy River
- Severn River
- South River

STUDY AREA II – POTOMAC

Maryland

Sub-Area P-1 (Washington-Metro)

- Potomac River (R.M.* 135–R.M.* 85)

Sub-Area P-2 (Lower Potomac)

- Potomac River (R.M.* 85–R.M.* 0)

Virginia

Sub-Area P-3 (Northern Virginia)

- Occoquan River

STUDY AREA III – RAPPAHANNOCK-YORK

Virginia

Sub-Area RY-1 (Rappahannock)

- Rappahannock River
- Ingram Bay
- Fleets Bay

Sub-Area RY-2 (York)

- York River
- Pamunkey River
- Mattaponi River
- Mobjack Bay

STUDY AREA IV – LOWER JAMES

Virginia

- James River
- Appomattox River
- Back River
- Elizabeth River
- Lynnhaven Bay

* = River Mile

TABLE 7-1 (cont'd)
CHESAPEAKE BAY STUDY
COMPOSITION OF STUDY AREAS

STUDY AREA V – LOWER EASTERN SHORE	STUDY AREA VI – UPPER EASTERN SHORE
Virginia	Maryland
Sub-Area LE-1 (Accomack-Northampton)	Sub-Area UE-1 (Choptank)
– Chesapeake Bay Drainage	– Choptank River
Maryland	Sub-Area UE-2 (Chester)
Sub-Area LE-2 (Pocomoke)	– Wye River – Chester River – Eastern Bay
– Pocomoke River – Manokin River	Sub-Area UE-3 (Elk)
Sub-Area LE-3 (Nanticoke)	– Northeast River – Elk River – C & D Canal
– Wicomico River – Nanticoke River	

Quality Management Plans required by Section 303(e) of the Federal Water Pollution Control Act Amendments of 1972, supplied the base for most of the data presented. The Maryland Department of Natural Resources, the Virginia State Water Control Board, and the Delaware Department of Natural Resources comprise the State agencies responsible for these plans within the Bay Area. The initial data base for this particular volume, as well as all other volumes of this Report, was presented in the *Existing Conditions Report* which was published in 1973. All materials and consulting agency data used are referenced in the Bibliography of this Report.

STUDY PARTICIPATION AND COORDINATION

Due to the wide scope, large geographical area, and many resources covered by the Chesapeake Bay Study, data input was required from many sources. Various Federal, State and local agencies throughout the Bay Region have customarily developed expertise in certain areas of water resource development. Although overall coordination of the study effort was provided by the Corps of Engineers, input from these various sources was required in order to obtain the best study coordination and problem identification. Therefore, an Advisory Group and a Steering Committee were established. Five Task

Groups were also formed to guide preparation of reports on related resource categories. They are:

(1) Economic Projection Task Group

(2) Water Quality and Supply, Waste Treatment, Noxious Weeds Task Group

(3) Flood Control, Navigation, Erosion, Fisheries Task Group

(4) Recreation Task Group

(5) Fish and Wildlife Coordination Group

Detailed information on the composition of each Task Group as well as the members of the Advisory Group is presented in the Chesapeake Bay Plan of Study and in Appendix 1 – "Study Organization, Coordination, and History."

This Appendix was prepared under the guidance of the members of the Water Quality and Supply, Waste Treatment, Noxious Weeds Task Group. It addresses the specific water quality categories agreed upon by its members in a Memo of Understanding subsequent to the Federal Water Pollution Control Act Amendments of 1972. The agreement provided that the statewide water quality management plans would be used as the basic water quality input to the Chesapeake Bay Study program and that the *Future Conditions Report* would include a summary of their findings. Chaired by the Environmental Protection Agency, other members of the Task Group include: The U.S. Departments of Interior; Agriculture; Health, Education, and Welfare; Navy; Commerce; and Transportation; the Federal Power Commission; the Energy Research and Development Administration; the U.S. Army Corps of Engineers; the Susquehanna River Basin Commission; and representatives of the States of Delaware, Maryland, the Commonwealths of Pennsylvania and Virginia, and the District of Columbia. This Task Group is concerned with the hydraulics and hydrology of the Bay system as well as problems of municipal and industrial water supply, waste water disposal, water quality degradation, noxious weeds control, and the overall effect of man's activities on the ecology of Chesapeake Bay.

CHAPTER II

WATER QUALITY IN THE CHESAPEAKE BAY REGION

Water quality is the term used to describe the condition of the water, whether it be in a river, bay, ocean, or underground. Good water quality, however, differs dependent on the point of view and the intended use. Man requires water for drinking that is free of color, pathogenic bacteria, and objectionable taste and odor. Industries which use water primarily for cooling and steam production require water free of materials such as chlorides, iron, and manganese, which may be harmful to equipment and limit production. Agriculture requires still a different quality of water, one which is free of degrading materials toxic to plant and animal life. Finally, each form of aquatic life requires water of varying qualities in order to maintain existence.

Normally, water contains minerals, nutrients, and aquatic organisms which nature provides. Due to man's activities, however, degrading materials are discharged to waters, especially in highly urbanized and industrialized areas. Excesses may cause reductions in the quality and the desired use of the water course. Under such conditions, the water is termed polluted, that is, it contains harmful or objectionable materials reducing its utility.

The sources of water pollution may be classified as either point or non-point. Point sources are those in which the degrading material is discharged through a specific point. Non-point sources are those in which the degrading material reaches the water course through flows originating over a large area.

The major point sources of water pollution are:

1) Municipal sewage outfalls

2) Industrial waste outfalls

3) Combined sewer overflows

The major non-point sources of water pollution are:

1) Agricultural runoff

2) Urban runoff

Water quality problems generally arise when the waste loads imposed by man exceed the water's capacity to assimilate them adequately. The resulting

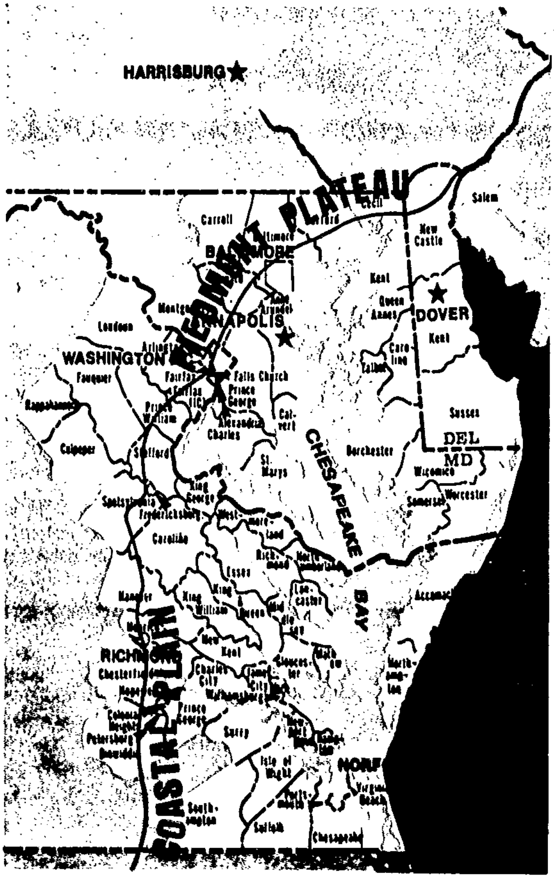


Figure 7-2: Geological Provinces and Fall Line

degradation can be very costly, both economically and ecologically. Increased costs of water treatment for municipal and industrial use, the closing of fishing areas and the resulting income loss for persons employed by the fishing industry, the loss of valuable recreation areas, the degradation of the aesthetical values of an area, the corrosion of structures exposed to water, destruction of fish and wildlife, and the general reduction in the use of receiving waters are all costs of impaired water. These costs apply to all bodies of water where man has extravagantly used the water to dispose of his

waste products. They also can serve as the base for studying the water quality problem, with the most likely goal being the reduction or eventual elimination of these costs and their associated water quality problems.

This chapter includes a brief description of the Bay Region, an inventory of the major waste discharges, and an identification of sources of pollution. Also identified in this chapter are those areas of each river basin in which waste loads have exceeded the natural assimilative capacity of the stream and where water quality problems have developed. Lastly, the management responsibilities section of this chapter cites the Federal and State agencies responsible for management of water quality and solution of associated problems in the Chesapeake Bay area.

DESCRIPTION OF THE REGION

THE CHESAPEAKE BAY REGION

Chesapeake Bay is one of the largest estuaries in the world, having a surface area of about 4,400 square miles and a length of nearly 200 miles. Located on the northern Atlantic Coastline of the United States, the Study Area consists of portions of the States of Maryland, Virginia, and Delaware. Five major rivers, the Susquehanna, Potomac, Rappahannock, York, and the James drain an area of about 64,200 square miles and provide nearly 90 percent of the total freshwater inflow to the Bay. The major physical features and socio-economic characteristics of Chesapeake Bay, as they relate to water quality, are described below. Detailed information on each of these characteristics can be found in the respective sections of the *Existing Conditions Report* (1) and the other Appendices of this *Future Conditions Report*.

GEOLOGY AND TOPOGRAPHY

The Chesapeake Bay Study Area contains two sharply defined and very different geologic provinces. They are the Atlantic Coastal Plain and Piedmont Plateau Provinces. Running parallel to the oceanic coastline in belts of varying width, these provinces are separated by a boundary line known as the Fall Line. Shown in Figure 7-2, this natural divide, passing through the major cities of Richmond; Washington, D.C.; and Baltimore denotes the tidal limit of the Bay's major western shore tributaries. The underlying structure is essentially unconsolidated, southeasterly-dipping, sedimentary layers such as sand, clay, marl, gravel, and diatomaceous earth resting on hard crystalline rocks.

The Eastern Shore of Maryland and Virginia, most of the State of Delaware, and much of the Study Area on the Western Shore are located in the Atlantic Coastal Plain Province. On the Eastern Shore, the topography is

generally low and featureless and areas of sharp elevation contrast are rare. The shoreline is not well defined, as much of it is either in wetlands or of broken land bordered by islands and shoals. Stream gradients are rather low and many of them are under tidal influence for nearly their entire length.

On the Western Shore, the Coastal Plain is characterized by a gently rolling landform which steadily progresses from areas of low elevation near the Bay to higher elevations near the Fall Line. For the most part, the shoreline is rather well defined, varying from gentle beaches to high cliffs. The gradients of the streams are steeper and the river channels deeper than those of the Eastern Shore.

The remainder of the Study Area, west of the Fall Line, lies in the Piedmont Plateau Province, a province that has a more complicated structure and more severe topographic variance than that of the Coastal Plain Province. It is characterized by low hills and ridges rising steadily as they approach the Appalachian Province. Steep stream gradients induce highly erosive flows, resulting in narrow and steep-sided river valleys. The underlying material of the Piedmont Province is older and more complicated than that of the Coastal Plain. Severe heat and great pressures have folded the original crystalline rock structure, creating metamorphic rocks. Molten material, forming igneous rock, has also intruded and can readily be found in the Piedmont Plateau.

On route to the Bay, the previously mentioned major rivers and their tributaries flow through several physiographic provinces. Rising in the Appalachian Plateau, the Susquehanna River flows for 453 miles through the Appalachian Ridge and Valley Province and the Piedmont Plateau to the Bay. The Potomac River, 407 miles long, flows through five physiographic provinces. From its source in the Alleghany Plateau, the Potomac passes through the Ridge and Valley and Blue Ridge Provinces, across the Piedmont Plateau to the Coastal Plain, and into the Bay. The York and Rappahannock Rivers, 130 and 184 miles long, respectively, rise in the Piedmont Plateau and flow across the Coastal Plain into the Bay. The source of the James River is in the Appalachian Mountains. For 434 miles, this river flows across the Blue Ridge and Piedmont Provinces, through the Coastal Plain and into the Bay.

CLIMATE

Best described as a temperate zone, the Chesapeake Bay Study Area's climate is influenced by its proximity to the Atlantic Ocean. Due to the large geographical size of the area and the effect of local weather patterns, however, wide variations in temperature and type and amount of precipitation occur.

Precipitation and temperature data are presented in Table 7-2 and Table 7-3

TABLE 7-2
CLIMATIC SUMMARY-PRECIPITATION DATA
MONTHLY NORMALS-YEARS 1931 thru 1960
(INCHES)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Elkton, Md.	3.44	2.99	4.19	3.60	4.25	3.96	4.35	5.02	3.56	3.23	3.55	3.19	45.33
Annapolis, Md.	3.24	2.57	3.62	3.31	3.83	3.51	4.14	4.50	3.46	2.63	2.78	2.85	40.34
Crisfield, Md.	3.54	3.15	4.01	3.64	3.69	3.31	5.05	5.05	3.83	3.37	3.24	2.92	44.89
Salisbury, Md.	3.64	3.21	4.13	3.34	3.62	3.49	4.39	6.01	4.44	3.50	3.21	3.13	46.13
Baltimore, Md.	3.43	2.89	3.82	3.60	3.98	3.29	4.22	5.19	3.33	3.18	3.13	2.99	43.05
Coleman, Md.	3.61	2.93	3.84	3.43	4.17	3.44	4.29	4.97	3.71	3.08	3.41	3.18	44.28
Solomons, Md.	3.55	2.78	3.61	3.50	3.76	3.45	5.37	5.00	3.59	3.11	3.33	2.97	44.22
Washington, D.C.	3.03	2.47	3.21	3.13	4.14	3.21	4.15	4.90	3.83	3.07	2.84	2.78	40.78
Richmond, Va.	3.44	2.90	3.42	3.35	3.71	3.75	5.61	5.54	3.65	3.00	3.04	2.97	44.21
Norfolk, Va. A.P.	3.33	3.21	3.45	3.16	3.36	3.61	5.92	5.97	4.22	2.82	3.05	2.74	44.94

Source: Existing Conditions Report, Appendix B (1)

TABLE 7-3
CLIMATIC SUMMARY TEMPERATURE DATA
MONTHLY AVERAGE-YEARS 1931 thru 1960
°F

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Elkton, Md.	33.8	34.6	42.1	52.8	63.3	71.8	76.2	74.5	67.8	54.5	43.4	33.3	54.5
Annapolis, Md.	36.1	36.4	43.1	53.8	64.1	73.2	77.5	76.0	69.9	59.2	48.1	38.1	56.3
Crisfield, Md.	39.3	39.9	46.5	56.9	66.9	75.3	79.4	78.0	72.6	62.2	51.2	41.2	59.1
Baltimore, Md.	34.8	35.7	43.1	54.2	64.4	72.5	76.8	75.0	68.1	57.0	45.5	35.8	55.2
Coleman, Md.	35.3	36.1	41.2	54.6	63.5	73.1	77.5	76.0	70.0	59.3	48.0	37.3	56.0
Solomons, Md.	38.5	39.0	45.3	55.5	66.0	74.6	78.8	77.8	72.1	61.2	50.4	40.3	58.3
Washington, D.C.	36.9	37.8	44.8	55.7	65.8	74.2	78.2	76.5	69.7	59.0	47.7	38.1	57.0
Richmond, Va.	38.7	39.9	46.7	57.1	66.5	74.6	78.1	76.5	70.2	59.2	48.5	39.7	58.0
Norfolk, Va.	41.2	41.6	48.0	58.0	67.5	75.6	78.8	77.5	72.6	62.0	51.4	42.5	59.7

Source: Existing Conditions Report, Appendix B (1)

for selected stations in the Bay Area. Average annual precipitation was 44 inches, with seasonal and geographical variations from 40 to 46 inches. Included in this total is an average of 13 inches of snowfall, occurring generally between the months of November and March.

Average temperature for the Study Area is 57 degrees Fahrenheit (°F), however, temperatures vary significantly between the northern and southern extremities of the Bay. At the head of the Bay, average temperatures of less than 55°F were recorded, while at the mouth, the average is nearly 60°F.

The Chesapeake Bay Area is affected by 3 major types of storms: (1) local thunderstorms affecting relatively small areas; (2) large storms or "lows" originating in the Rocky Mountains, Gulf Coast, or Pacific Northwest, moving eastward; and (3) tropical storms or hurricanes originating in the Caribbean or South Atlantic moving northward across the eastern part of the United States.

POPULATION

Approximately 7.9 million persons resided in the Chesapeake Bay Study Area in 1970, more than double the 1940 figure. While all study sub-areas experienced increases in population, approximately 70 percent of the total growth occurred in either the Baltimore or Washington Economic Subregions. These two subregions are shown along with the other major subregions of the Bay Area in Figure 7-3. Population data and growth rates for the major economic subregions are presented in Table 7-4.

TABLE 7-4

POPULATION GROWTH IN THE STUDY AREA SINCE WORLD WAR II BY ECONOMIC SUBREGION

Subregion	1940 Population	1970 Population	Absolute Change	Percentage Change
Baltimore, Maryland	1,481,179	2,481,402	+ 1,000,223	+ 67.5
Washington, D.C.	1,086,262	3,040,371	+ 1,954,109	+179.9
Richmond, Virginia	437,103	728,946	+ 291,843	+ 66.8
Norfolk-Portsmouth, Va.	467,229	1,121,856	+ 654,627	+140.1
Wilmington, Del. SMSA	248,243	499,493	+ 251,250	+101.2
Total Study Area	3,720,016	7,872,068	+ 4,152,052	+111.6
Total United States	132,165,129	203,211,926	+71,046,797	+ 53.8

Source: U.S. Census Data

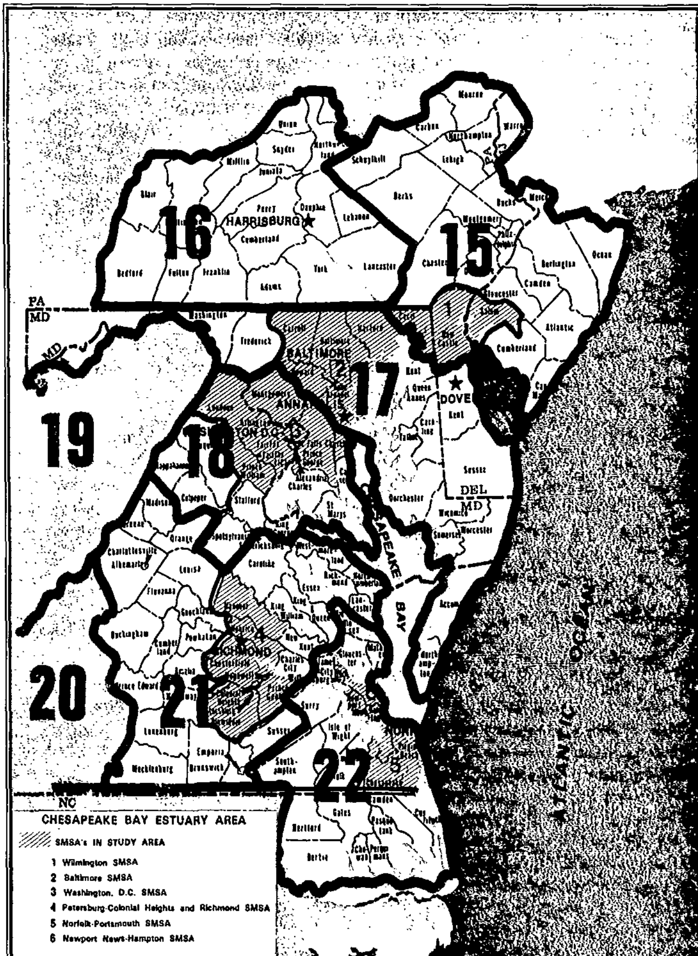


Figure 7-3: Economic Subregions
Source: Existing Conditions Report(1)

Most important to water quality are the population densities. They serve as general indicators that water quality problems may develop if the waste loads exceed treatment plant and receiving water capacities. The counties of Baltimore, Montgomery, and Prince Georges in Maryland, and Fairfax and Arlington in Virginia, as well as the major Cities of Baltimore; Washington, D.C.; Richmond; Alexandria; Newport News; Hampton; Portsmouth and Norfolk have the highest densities in the Study Area (1970 Census Data). Nearly 80 percent of the total population has concentrated in these urbanized areas and trends indicate that growth will continue there in the future.

ECONOMY

Rich in economic activity, the Chesapeake Bay Region derives its basic income from a variety of industries, the largest employer is the Service Sector (professional, health, educational, and recreational services) with approximately 26 percent of total employment in the Bay Region being service oriented in the year 1970. Following were the Wholesale and Retail Trade Sector (17 percent), the Manufacturing Sector (16 percent), and the Public Administration Sector (14 percent). The heavy water·impacting industries in the Bay Area as indicated in Figure 7-4, are noticeably below the National average. The distribution of employment in these various economic sectors is shown in Figure 7-4.

Employment in the Bay Area averaged 3.3 million people in 1970, with the unemployment rate being significantly lower than the National average. Per capita income for the residents of the entire Bay Area was $3,690 compared to $3,390 for the entire United States.

Economic activity and water quality in the surrounding region are often closely related. Industrial development directly affects water quality, and water quality, to some extent, affects the development of industry. The level and type of economic activity are factors in determining the amount of water rquired for industrial purposes, and the extent of the impact on water related activities.

RESOURCES

Chesapeake Bay, one of the most productive estuaries in the world, contains many valuable water and land related resources. The use of any of these resources impacts to some degree upon the others and man. Impairment of

one resource, therefore, will directly affect those resources which depend upon it, and ultimately all others. The major resources and resource uses of Chesapeake Bay which closely relate and interact with water quality are land use, minerals, soils, water supply, recreation, and fish and wildlife. An overview of each follows.

Land use, which has a major impact on water quality, varies greatly in the Region and is shown in Table 7-5. The areas of high residential, commercial and industrial development have been shown to degrade the quality of water because of the heavy and complex wasteloads imposed. Consequently, areas with degraded water can serve as a limiting factor to future development. Agricultural lands can also impose heavy loads to the water from farmland and feedlot runoff.

EMPLOYMENT BY ECONOMIC SECTORS, STUDY AREA AND UNITED STATES, 1970 (PERCENT)

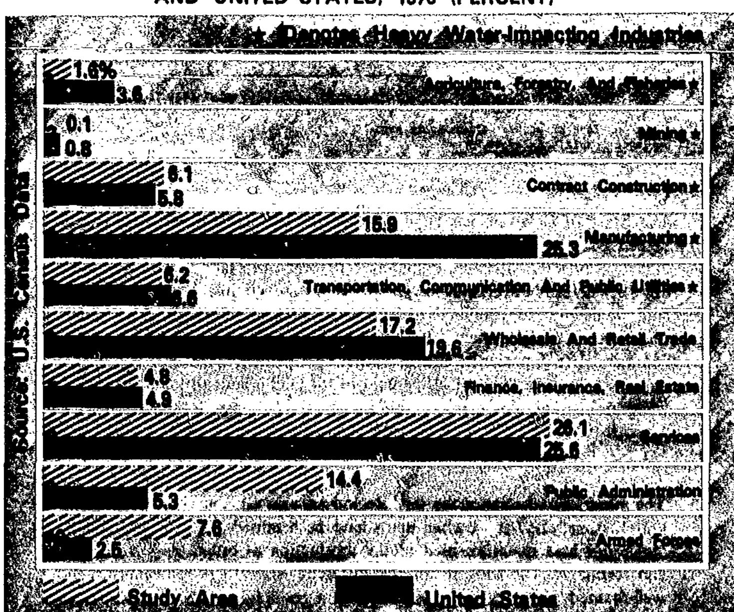


Figure 7-4: Employment by Economic Sectors, Study Area and United States, 1970 (Percent)

TABLE 7-5

LAND USE--CHESAPEAKE BAY STUDY AREA (PERCENT)*

Land Use Type	STATE/DISTRICT Delaware	District of Columbia	Maryland	Virginia	Total Bay Area
Residential	3.6	28.5	5.2	3.1	3.6
Commercial	0.4	5.3	0.5	0.3	0.4
Industrial	0.4	2.9	1.0	0.4	0.6
Public/Semipublic	3.1	10.0	4.3	4.6	3.9
Agriculture	47.1	0	38.5	22.4	30.4
Woodlands	30.2	0	39.0	59.1	49.3
Park Lands	2.2	10.0	1.9	2.0	2.0
Wetlands	8.4	0	6.1	3.4	4.8
Open Land, Railroads, and Highways	4.6	43.3	3.5	4.7	5.0
TOTAL	100.0	100.0	100.0	100.0	100.0

*Includes only portions of states within Study Area.
Source: Existing Conditions Report

The State of Delaware has large areas devoted to agricultural lands (47.1 percent) and wetlands (8.4 percent). Maryland, while considered a "major industrial region" with approximately 1 percent of its land in industrial use, has 38.5 percent of its lands in agricultural use. In Virginia, large amounts of land are devoted to woodlands (59.1 percent) and agriculture (22.4 percent). The District of Columbia is largely devoted to residential (28.5 percent), commercial (5.3 percent), and industrial (2.9 percent) uses. For the entire Bay Area, however, almost 80 percent of the land is agricultural or wooded, while residential, commercial, and industrial land uses total less than 5 percent.

The minerals and soils of the Bay Region are also valuable resources. Sands, gravel, stone, clay, and certain marls have been mined and provide building stone and base materials used in the production of brick, pipe, roadways, and fertilizers. The soils are of five different "soil orders" and range from well-drained sandy types which support a good farming industry in west central Maryland to poorly drained muck soils found in the extreme southern portion of the Study Area. Their impacts on water quality occur

when sand and gravel and stone quarrying operations induce sediment loads in the streams causing turbid conditions. Improper farming techniques can also cause major soil erosion problems which degrade Study Area waters. See Appendix 4, Water and Related Land Resources, for a more detailed explanation of land use in the Chesapeake Bay Area.

The surface and groundwaters of the Region serve as the sources of water for municipalities, industry, and agriculture. About 20 percent of the total freshwater used in the Region is supplied by groundwater with the Eastern Shore almost completely dependent upon it. The major cities of Baltimore, Washington, Richmond, Newport News, and Norfolk, however, depend primarily on surface water for their supply. The quality of this water is very important, as each intended use requires water of a different quality. In addition to the problems encountered in supplying water of good quality during normal flows, periods of high and low flow greatly complicate the situation. Low flows, occurring during summer droughts, increase the percentage of wastewater in rivers and limit downstream usages. Spring floods carry large amounts of sediment, increasing the cost of treatment and frequently overloading treatment plants.

Water-oriented recreation in the Chesapeake Bay Region varies widely. Swimming, picnicking, boating, hiking, hunting, camping, fishing, and nature studies comprise the major activities in the Region. Presently, the major urban areas show the need for increased swimming, camping, and picnicking facilities. Water quality along with other factors can limit recreation potential of an area. Impaired water quality can create aesthetically unpleasing conditions which limit present and expanded use of an area. Also, polluted waters can force closure of existing areas for public health reasons. Conversely, extensive use or development of an area for recreational use may result in the degradation of waters receiving intensive use.

Wide variations in salinity levels is one of the factors which enables the Chesapeake Bay to support a variety of aquatic life forms. The most important species, based on dollar value, are oysters, crabs, clams, menhaden, and striped bass. In 1970 alone, Chesapeake Bay landings of finfish and shellfish totaled 630 million pounds valued at $41 million. Degraded waters, which deplete dissolved oxygen supplies, often cause fish kills and result in the disruption or transfer of natural spawning areas. Also, concentrations of toxic chemicals in the tissue of fin and shellfish may force the closing of their harvesting areas.

The previously mentioned resources are not the only ones in the Chesapeake Bay Region which impact upon water quality. The brief discussion of each was presented solely to identify the major resources of the Bay Region which may affect water quality, both now and in the future. Detailed

information on each of the resources may be found in Appendix C of the *Existing Conditions Report* and the appropriate appendixes of this *Future Conditions Report*. Specific water quality related problems and conflicts were not mentioned here, as they will be covered in the "Existing Water Quality Conditions" section of this appendix.

HISTORY

Historically, three basic eras have characterized the development of water quality in the United States and the Chesapeake Bay Region. Based upon man's knowledge of and concern for water quality, each era differs from the others and generally reflects the changing attitude of a growing Nation and prospering Chesapeake Bay Region.

Initially, concern for water quality developed out of the need for suitable drinking water. However, the simple aesthetical parameters of taste, odor, and clarity were the only methods used to determine "safe" water conditions. Widespread use of the water resource was condoned and little regard for conservation was attempted, as mere survival was deemed most important. Land clearing, to develop a growing Nation, was carried out without concern for erosion. Towns were also constructed near streams without concern for future development and the associated problems of waste disposal. In fact, no waste water collection systems existed and no relationship between water and disease had yet been developed. Fortunately, no major problems developed because the number of persons involved was limited and the water resource was not stressed beyond its assimilative capacity.

In the second era, from the 1850's to the early 1940's, populations began to concentrate around the sources of growing employment and large cities soon developed. Outbreaks of cholera and typhoid in these cities aroused considerable concern, the reasons remaining unknown until Pasteur's germ theory of 1862 provided the first correlation between water pollution and disease. The two most important concepts of this era, then, became the preservation of industrial growth and the protection of populations from waterborne pathogens. The construction of water treatment facilities was one of the first attempts to cope with the disease problem until it was realized that control of waste discharges would also be necessary. Primary wastewater treatment systems based on chemical precipitation were developed around 1890. Concentrations of ammonia, nitrogen, nitrites, and nitrates were monitored to evaluate "safe" water. However, these systems failed to evaluate bacteriological safety of water. Biological wastewater treatment methods were then pioneered and emerged in 1914 (2). Post chlorination was also a significant development in this era; its purpose being the disinfection of wastewaters prior to disposal in the receiving waters.

The third era, from 1940 to the present, developed as increasing amounts of leisure time and greater environmental awareness began to focus more

attention on the quality of the Nation's waters. Public demands for improved water quality intensified and standards were consequently developed to improve the overall utility of the water resources. Federal, State, and local agencies were also created to serve both regulatory and planning functions as they relate to water quality. Water pollution control acts as early as 1948 and continuing through 1956 and 1965 first recognized the need to eliminate harmful pollutants other than pathogenic bacteria from the increasingly complex wastewaters. The more recent Water Pollution Control Act Amendments of 1972, however, reflect the most significant step towards comprehensive treatment of water quality and its problems to date. Comprehensive management plans on both the State and local level are required by this Act. In the development of these plans, consideration must be given to advanced waste treatment; the non-point sources of pollution; population projections; projected waste loadings for municipal and industrial point sources; and most importantly, adequate implementation–including schedules of compliance with new or revised standards. The more in-depth research with regard to the effects of our wastes on the ecosystem, the sources of existing water pollution problems, and methods of preventing future degradations have resulted in an increased public awareness of water quality problems and their solutions.

DESCRIPTIVE PUBLICATIONS

The major sources of information for this report were provided by the 303(e) and 305(b) Water Quality Management Plans. These reports are required by the Federal Water Pollution Control Act Amendments of 1972 and were obtained from the responsible State Water Quality Planning Agencies within the study area. Preparation of individual river basin reports was generally accomplished by local planning agencies with the States responsible for overall coordination and review on a state-wide basis. Background information was obtained from various Federal, State, and local agencies and research institutions that are investigating various aspects of water quality. A complete listing of the reports consulted is included in the Bibliography of this appendix.

WATER QUALITY PARAMETERS

The parameters used to measure water quality are of three major types, that is, physical, chemical, and biological. These basic parameters, their common abbreviations, and what particular quality of water they reflect are listed in Table 7-6. In addition to this table, a description of the regularly monitored parameters as well as those which are no less important and will certainly be monitored regularly in the near future is provided. Also included are the effects of each parameter on the environment along with typical values that, based on the Environmental Protection Agency (EPA) Water Quality Criteria of 1972, indicate when degradation of Bay Area waters may be occurring.

TABLE 7-6
WATER QUALITY PARAMETERS

PARAMETER (UNIT)	ABBREVIATION	REFLECTS
Physical:		
Solids, Dissolved (mg/1)	DS	Salts of metals, pigments and other substances which pass through a glass fiber filter.
Solids, Suspended (mg/1)	SS	Organic and inorganic coarse materials retained on a glass fiber filter.
Solids, Total (mg/1)	TS	All dissolved and undissolved solid substances.
Temperature (°C)	–	The thermal state of a substance with respect to its ability to transmit heat to its environment.
Turbidity (Jackson Units)	JTU	Material in water affecting light penetration and transparency.
Chemical:		
Ammonia Nitrogen (mg/l)	NH_3-N	Common nitrogen form in STP effluents, released by decomposition of organic matter.
Chlorophyll *a* (mg/m³)	–	Amount of algal growth in water.
Dissolved Oxygen (mg/1)	DO	Weight/volume of DO in water; increases with photosynthesis and decreases with exertion of organic decomposable wastes and respiration.
Hydrogen Ion Activity (Standard Unit)	pH	Acids and alkalis (acidity).

TABLE 7-6 (Cont'd)
WATER QUALITY PARAMETERS

PARAMETER (UNIT)	ABBREVIATION	REFLECTS
Kjeldahl Nitrogen, Total (mg/l)	TKN	Organic nitrogen (found in plant cells) and NH_3-N.
Nitrate Nitrogen (mg/l)	NO_3-N	Completely oxidized form of nitrogen in STP effluents utilized by plants as nutrients and by bacteria.
Nitrite Nitrogen (mg/l)	NO_2-N	Oxidized form of nitrate nitrogen; low concentrations in natural water.
Phosphorus, Total (mg/l)	TP	All phosphorus in water expressed in the elemental form.
Phosphate, Total as PO_4 (mg/l)	TPO_4	All phosphates in water expressed as PO_4.
Microbiologic:		
Biochemical Oxygen Demand (mg/l)	BOD-5	Oxygen demand by microbes in decomposition of organic waters during 5 days.
Coliform, Fecal (MPN/100 ml)	–	Number of coliform bacteria of fecal origin from warm-blooded animals.
Coliform, Total (MPN/100 ml)	–	All coliform bacteria in water including those in soil and plants as well as warm-blooded animals.

Source: Potomac River Basin Report, 1962-1973 (3).

By monitoring and studying water quality parameters to determine how much of each is detrimental, standards can and have been developed to control water pollution. These standards, required of each state by the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), reflect the goal of water quality management for the present and future, and are therefore presented in chapter Three of this appendix.

BIOCHEMICAL OXYGEN DEMAND (BOD-5)

BOD is the amount of oxygen required to stabilize or decompose organic matter by aerobic (requiring oxygen) biological action. Having two components, carbonaceous and nitrogenous, the BOD curve is time dependent and can be traced as in Figure 7-5. For the first twelve days, most of the oxygen demand is due to the decomposition of the carbonaceous component. From that time on, the oxidation of the nitrogenous component dominates until the total demand tapers off slowly after 20 days.

Usually expressed in the form of five day BOD (BOD_5), this measure is used to indicate the relative strength of pollution in the water. Thus, the greater the degree of pollution, the higher the oxygen demand and resulting BOD_5. From the BOD curve of Figure 7-5, it can be seen that BOD_5 is almost totally due to the oxidation of the carbonaceous component. This, however, is a useful indicator of short term oxygen demand. Generally, BOD_5 values greater than 5 milligrams per liter (mg/1) indicate polluted water.(4)

Two other measures of oxygen demand, ultimate oxygen demand (UOD) and chemical oxygen demand (COD) have also been used. UOD, also shown in Figure 7-5, is the total amount of oxygen consumed by a water sample after

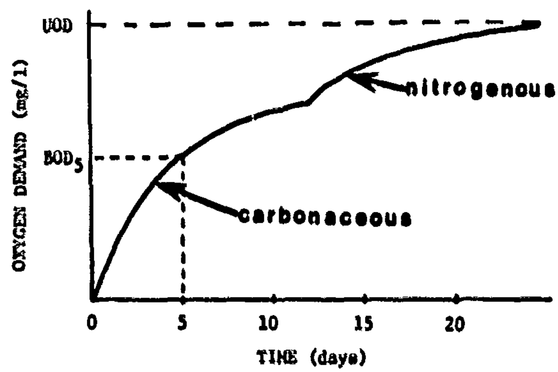


Figure 7-5: BOD Rate Reaction Curve

both the carbonaceous and nitrogenous cycles are completed. COD is a measure of the total quantity of oxidizable matter in the water and has been useful because it can closely correlate to BOD_5 data in a shorter time period, from fifteen minutes to three hours.

BACTERIOLOGICAL INDICATORS

Total coliform bacteria include both aerobic (requiring oxygen) and anerobic (not requiring oxygen) bacteria found in the soil, on plants, and in the excreta of man and animals. Fecal coliform bacteria, although harmless to man, are found along with pathogenic bacteria in domestic waste products. Since pathogenic bacteria have been proven to carry disease and methods for reliable detection of these organisms have not yet developed, concentrations of fecal coliform bacteria have been used as indicators of pathogenic bacteria presence.

Measured by the most probable number of bacteria per 100 milliliter of water sample (MPN/100 ml), fecal coliform densities are monitored at public water supply, water contact recreation, and shellfish harvesting areas. Concentrations of 200 MPN/100 ml in water contact recreation areas, for example, have generally been accepted as maximum permissable values. Typical median fecal coliform levels are not permitted to exceed an MPN of 14/100 ml of sample and not more than 10% of samples shall exceed 43 for a 5 tube, 3 dilution test or 49 for a 3 tube, 3 dilution test(4).

SUSPENDED SOLIDS (SS)

Suspended solids are those which remain suspended in water and cannot pass through the holes in a standardized filter (typically one-millionth of an inch in diameter). Major sources of SS are agricultural runoff, industrial operations, municipal wastewaters, construction activities and storm water runoff. Serving as transport mechanisms for pesticides and other toxic substances, these solids can also interfere with light penetration and restrict primary plant production. SS concentrations of less than 25 mg/l have been shown to have no harmful effects on freshwater fisheries; however, impacts on fisheries may be expected when concentrations exceed 80 mg/l. (4)

DISSOLVED SOLIDS (DS)

Dissolved solids measure the total amount of organic and inorganic material which has been chemically dissolved in water. Sulfates, carbonates, phosphates, nitrates, and chlorides are among the most common dissolved solids in surface waters. Measured in mg/l, the total quantity of dissolved solids vary widely and often determine the abundance of plant and animal life in the aquatic system.

TEMPERATURE

Temperature, in degrees Centigrade (°C), controls to a great extent the type of aquatic organisms that inhabit certain reaches of water. All aquatic organisms have upper and lower thermal tolerances and will seek out their preferred temperatures for reproduction and growth. Suuden changes in temperature, even though they may be slight, may form thermal barriers and upset the delicate balance of the aquatic ecosystem. An increase in temperature above ambient but below the upper thermal tolerance can increase both algal and aquatic productivity. Also, stress due to a sudden decrease in temperature, as experienced during periods of power plant shutdown, can upset aquatic ecosystems.

TURBIDITY

Turbidity measures the amount of light transmitted through and indirectly the amount of suspended matter in water. Turbid waters absorb heat rapidly near the surface causing density stratification and possible interference with vertical mixing and oxygen transfer. Average turbidities of over 130 Jackson Turbidity Units (JTU) have been shown to diminish fish productivity. (4)

DISSOLVED OXYGEN (DO)

Dissolved oxygen is the amount of oxygen dissolved in water. Dependent mostly upon atmospheric pressure and temperature, adequate dissolved oxygen is necessary for the survival of fish and other aquatic organisms. Cold water in low altitudes retains more DO than warm water in high altitudes.

Low dissolved oxygen concentrations, often responsible for "fish kills" and destruction of valuable life forms, are usually the result of the discharge of organic solids having a high BOD_5. These discharges consume the oxygen supply normally found in receiving waters and have the effect of suffocating fish populations and other organisms requiring oxygen for survival. Measured in mg/l, DO concentrations of less than 5.0 mg/l generally will not support good fisheries. (4)

NUTRIENTS

Nutrients, most commonly found as nitrogen, carbon, and phosphorous are naturally present in waters but are often greatly supplemented by municipal wastewater discharges and runoff from fertilized areas. Although necessary for organism growth and development, excessive concentrations can over-fertilize plant life and cause accelerated eutrophic, or nutrient rich, conditions. Significant reductions in dissolved oxygen contents usually follow causing unnatural movement of species to other waters. This movement can disrupt entire food chains, effecting all forms of fish and wildlife, and ultimately, man.

The major nutrient parameters consist of the many forms of nitrogen and phosphorous listed and described in Table 7-6. Various concentrations of each are significant, however, the exact relationships between algal activity and nutrients has not yet been determined. The levels of phosphorous that the EPA has established in order to limit eutrophication are: for free flowing streams--0.1 mg/l, at points where free flowing streams enter lakes or reservoirs--0.05 mg/l, and in lakes and reservoirs--0.025 mg/l. The limiting nitrogen concentrations are between 0.1 and 1.0 mg/l. (4)

CHLOROPHYLL

Chlorophyll is a key material of photosynthesis, responsible for the green pigment of plants. It serves as a very important link in the photosynthetic process, which involves the transformation of light energy into chemical energy necessary for the growth of plants. By measuring the amount of chlorophyll *a* (a form of chlorophyll found in waters) in either micrograms per liter ($\mu g/l$) or milligrams per cubic meter (mg/m^3), the size of a watercourse's green plant crop, or algal biomass may be predicted. While permissable levels of chlorophyll "a" are difficult to determine and dependent on location, concentrations of approximately 100 $\mu g/l$ give the water a green appearance and are indicative of eutrophic conditions; about 200 $\mu g/l$ the water is very green; and at about 300 $\mu g/l$, the appearance is that of thick pea soup.

HYDROGEN ION ACTIVITY (pH)

A measure of hydrogen ion concentration, pH reflects either acidic or alkaline conditions. Neutrality is represented by a pH of 7. Basic conditions (pH above 8.5) can decrease reproductive capabilities in many aquatic species and acidic water (pH less than 6) can exert stress or kill all forms of aquatic life.

HEAVY METALS

Mercury, lead, zinc, chromium, cadmium, and arsenic are of importance because of their toxicity to plants and animals and their relative long lives. The most significant problem is that fish and shellfish concentrate these metals in their tissues, affecting the natural food chain and presenting a consumption hazard for man.

Toxicity data is reported as median lethal concentration (LC_{50}). This symbol signifies the concentration in mg/l that kill 50 percent of test organisms within a specified time span, usually 96 hours. Obviously, LC_{50} values are not safe concentrations, and are not intended as such. Safe levels are usually much lower and must be determined for each lifeform, based on a separately determined LC_{50} and limiting criteria developed by the Environmental Protection Agency (4). A table of lethal concentration

factors and maximum permissable concentrations for dozens of heavy metals has been prepared for freshwater and marine fish and wildlife and is presented in Appendix 15, "Biota."

EXISTING WATER QUALITY CONDITIONS

Water quality conditions in the Bay Area vary widely, depending on proximity to urban and industrial areas and the intended use of the water. In general, the quality of water in the Bay proper is good, with most quality problems occurring in the estuaries of the Bay's tributaries. However, problems in the tributaries are very important because degraded waters in these locations can and ultimately do effect water quality conditions in the entire Bay Region. For this reason, all data, both existing and future, have been surveyed and will be presented by separate river basin segments designated by the States of Maryland, Virginia, and Delaware.

This particular segment of the report presents existing water quality conditions for each of the six major water quality study areas in the Chesapeake Bay Region (Figure 7-1). Study sub-areas, again based on river basin segments designated by the States of Maryland, Virginia, and Delaware, have been combined to simplify presentation and are contained in Table 7-1. Major sources of information and most of the data presented in this section were obtained from the available 303(e) and 305(b) water quality reports prepared by each State in compliance with the Federal Water Pollution Control Act Amendments of 1972.

Water quality coverage includes: a physical description of each sub-area, a discussion of historically measured water quality parameters, a list of major municipal point source discharges, a discussion of non-point source problems, and an inventory of all known areas within the basins which have experienced water quality degradation. Depth of coverage for each basin may vary, as several areas have been studied more closely and extensive data have been made available. Also, pertinent data, such as shellfish closing areas, have been presented when available.

STUDY AREA I–BALTIMORE

The Baltimore Study Area is composed of three sub-areas: B-1, B-2, and B-3. These sub-areas were formed from the major river basins in the area as shown in Table 7-1. Completely within and under the jurisdiction of the State of Maryland, this Study Area is shown on Plate 7-1 at the back of this appendix. Most of the information presented in this section was obtained from the Maryland Water Quality 75 305(b) Report (5), and the Patapsco (6) and Patuxent (7) 303(e) Water Quality Management Plans.

SUB-AREA B-1 (UPPER WESTERN SHORE)

This sub-area was formed from the three major river basins in Northeastern Maryland, namely the Lower Susquehanna, the Bush, and the Gunpowder River Basins. Following is a description of existing water quality conditions for each segment as summarized from the 1975 Maryland Water Quality 305(b) Report. (5)

LOWER SUSQUEHANNA RIVER AREA

Description. The Susquehanna River is the largest freshwater stream on the Eastern Seaboard of the United States, contributing 50 percent of the freshwater flow to Chesapeake Bay. The entire basin, including a large part of the Commonwealth of Pennsylvania and 12 percent of the State of New York, is about 250 miles long, 170 miles wide, and populated by approximately 3,600,000 persons (9). Serving only one percent of the entire basin's population after crossing the Pennsylvania State Line into Northeastern Maryland, the river flows into the reservoir of Conowingo Dam before entering Chesapeake Bay at Havre de Grace. The Maryland Area is primarily agricultural containing only small town and summer recreational developments. Four of the more important streams wholly or partially in Maryland contributing to the Susquehanna are Broad, Conowingo, Octoraro, and Deer Creeks. The boundaries of this segment, within sub-basin B-1, are shown on Plate 7-1.

The Susquehanna River and its tributaries support important freshwater fisheries. Also, the Baltimore City water supply intake is located just above the Conowingo Dam in Eastern Harford County and is used during low flow conditions to augment the City's other reservoirs in the Patapsco and Gunpowder drainage areas. An aqueduct runs to the Montebello Water Treatment Plant in the City.

The waters of the Lower Susquehanna River sub-basin are designated Class I for water contact recreation and aquatic and wildlife uses, except as follows. The mainstems of Basin Run, Kellogg Branch, North and South Stirrup Runs, and Deep Run, and Deep Creek and all tributaries above Eden Mill Dam are designated Class III - natural trout waters. Deer Creek and all tributaries below Eden Mill Dam, except those designated Class III, and the mainstem of Octoraro Creek are designated Class IV - recreational trout waters.

Water Quality. A summary of the water quality of the streams in the Lower Susquehanna River Area is shown in Table 7-7. The evaluation is based on parameters and standards developed by the State of Maryland.

In general, the quality of water in the mainstem of the Susquehanna River is good to excellent. Studies by the Maryland Water Resources Administration

TABLE 7-7
WATER QUALITY IN THE LOWER SUSQUEHANNA RIVER BASIN

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Susquehanna River (below Conowingo)	Yes	Yes	Yes	*	Penna. portion contributes main enrichment loading. *Exceeded numerical limit during high flow conditions. Turbidity also high during high flow conditions.
Deer Creek	Yes	Yes	Yes	*	Heavy agricultural runoff - also septic system failures and STP in Pennsylvania. High bacteria and turbidity during heavy rainfall.
Octoraro Creek	Yes	Yes	Yes	*	Heavy agricultural runoff (Pa. and Md.) and sanitary waste discharges (Rowlandsville). *Bacteria high during runoff.
Susquehanna River (above dam)	Yes	Yes	Yes	*	Penna. portion contributes main enrichment loading. *Exceeded numerical limit during high flow condition - turbidity also high during high flow conditions.
Broad Creek	Yes	Yes	Yes	*	Agricultural runoff area - lake has algal blooms. *Exceeded numerical limit.
Castleton Area	-	-	-	-	Septic system areas need improvement in headwater area.
Oakwood Area	Yes	Yes	Yes	*	Agricultural runoff and septic systems area. *Exceeded numerical limit.
Penna. Line Area	Yes	Yes	Yes	Yes	Small town rural area - area to be sewered (Whiteford).
Havre De Grace Area	Yes	Yes	Yes	Yes	Urban runoff area - housing developments - areas to be sewered.
Bainbridge Area	Yes	Yes	Yes	*	Trailer park discharges and septic system area. *Exceeded numerical limit.
Camp Ramblewood Area	-	-	-	-	Small area - no known streams.

*Yes or no does not adequately describe water quality (refer to comments).

Source: 1975 Maryland Water Quality 305(b) Report.(5)

(WRA), the Environmental Protection Agency (EPA), and Goucher College have shown that dissolved oxygen, pH, and concentrations of heavy metals are usually within acceptable limits. Nutrient concentrations, particularly at times of high river flows, have exceeded acceptable values due to upstream loadings of urban and agricultural runoff. Concentrations of nitrate nitrogen (NO_3) and total phosphorous (P) were often above values that are indicative of waters that could possibly support excessive algal blooms.

The main causes of high nutrient, bacteria, and chlorophyll *a* values are the many discharges (municipal and industrial) as well as agricultural and land

runoff in the entire Susquehanna River Basin which concentrate above the Conowingo Dam.

Within the Maryland portion there are only four major municipal sewage treatment plants (average flows greater than 0.1 million gallons per day [mgd]). They are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-1, also at the back of this appendix. Occasionally high bacterial counts from these plants during low flow periods may result in local degradations, but generally the great assimilative capacity of the river prevents severe degradations.

Scattered industrial waste discharges are also found in the Maryland Area of the Susquehanna River. Most of these are small, causing only local degradation of water quality.

The upper river above Conowingo Dam is under study due to the expansion of the Peach Bottom Nuclear Power Station 2.5 miles above the Maryland Line. The increased thermal discharge is the main concern in the Upper Conowingo Lake Area. The increased nutrient load with resulting higher chlorophyll *a* is also being studied.

Low dissolved oxygen problems have occurred in the past below Conowingo Dam as the result of the operation of the dam for electric power generation. When water was being stored, downstream flows were reduced to the point where fish were trapped below the dam in pools, reducing dissolved oxygen contents and causing occasional fish kills. A minimum of 5,000 cfs is now required when anadromous fish are in the area.

The Susquehanna River mainstem from Port Deposit to the mouth has heavy boat use during the summer season. Large live-in boats are plentiful and contribute untreated discharges. The boat use problem should be resolved in the future when Federal regulations will require treatment or no discharge.

In the freshwater tributaries only occasional violations of bacteria standards are found in sections of Broad, Conowingo, Octoraro, and Deer Creeks. Most of these violations are due to septic tank failures and agricultural waste runoff. A new treatment plant at Stewartstown in Pennsylvania on Deer Creek (Ebaughs Creek) has caused concern for the trout fishery and water quality. The plant has advanced treatment to meet effluent discharge requirements and is being continually monitored.

The importance of the Susquehanna River to the whole Bay is evident by the nutrient loading it contributes in comparison to the total from all tributaries (total PO_4 - 54%, Inorganic P - 60%, TKN - 62%, NO_2 and NO_3 - 66%, NH_3 - 72%, and TOC - 55%). The Upper Bay Area is therefore almost totally dependent on the Susquehanna River as its main source of flow and nutrients.(10)

With the drainage area of the Susquehanna River shared by three States, the management of the water resources of this drainage basin is necessarily an interstate matter. Pennsylvania and Maryland are committed to reducing the loads (especially nutrients) discharged to the river to protect both the river and the Upper Chesapeake Bay. Increased algal blooms, especially of the blue-greens, are the main concern. The Susquehanna River Basin Commission supervises and coordinates interstate planning and action.

A joint agreement between the States of Maryland and Pennsylvania for the Lower Susquehanna River and Upper Chesapeake Bay Area has set a minimum of 80 percent reduction of phosphorous as P from point sources (11). Additional treatment may be needed where studies document this need. The future trend should be toward reduced nutrients and chlorophyll *a* values. Bacteria levels should also be reduced with increased sewer extensions and additional treatment. Land runoff, however, will remain a significant factor until land treatment practices are improved.

BUSH RIVER AREA

Description. The Bush River area lies within the northeastern section of Maryland in Harford County as shown on Plate 7-1. The area contains some highly populated suburbs and is being expanded and developed rapidly along the Route 40 and Interstate 95 corridors in the Bel Air, Edgewood, Aberdeen, and Havre de Grace Areas. Much of the tidal estuary area is restricted government reservations (Aberdeen Proving Grounds and Edgewood Arsenal) and, except for active post area, the land and water are relatively free from development. Main tributaries to the Bush River are Swan Creek, Winters Run, Bynum Run, Romney Creek, and James Run.

Bynum Run and all tributaries above Atkisson Reservoir are designated Class III - natural trout waters. Winter's Run and all tributaries above Atkisson Reservoir are designated Class IV recreational trout waters. All estuarine portions of the tributaries are designated Class II for shellfish harvesting, except for the Bush River and tributaries above a line from Fairview Point to Chilburg Point, Romney Creek and tributaries above Briar Point, and Swan Creek and tributaries above the mouth which are designated as Class I waters for water contact recreation and aquatic and wildlife uses.

Water Quality. Table 7-8 indicates the water quality of the tributaries in this segment with respect to various water quality parameters and standards developed by the State of Maryland.

Water quality conditions in the mainstem of the Bush River can generally be classified as good. Monitoring of water quality by the Environmental Protection Agency (EPA), the Chesapeake Bay Institute (CBI) of the Johns Hopkins University, and Goucher College have indicated that dissolved oxygen, pH, and temperature standards were met from February to September 1972. Nutrient and bacteria concentrations, however, exper-

TABLE 7-8
WATER QUALITY IN THE BUSH RIVER BASIN

SEGMENT	NO.	MEETS WATER QUALITY STANDARDS				COMMENTS
		Temp.	pH	D.O.	Bacteria	
Swan Creek	(01)	yes	yes	yes	no (upper end)	STP discharges & failing septic system & agricultural area in headwaters
Bush River	(02)	yes	yes	yes	no (upper end)	Sanitary waste discharges and failing septic systems.
Bynum Run	(03)	yes	yes	yes	no	Agricultural and Sanitary waste problems
Winters Run	(04)	yes	yes	yes	no	Agricultural runoff in upper end-septic system failures in lower-developing urban area (erosion & siltation) - some industrial discharge
Aberdeen Proving Grounds Area	(05)	yes	yes	yes	no	Heavy STP discharges - advanced treatment needed
Susquehanna Flats Area	(06)	yes	yes	yes	yes	Small area - no known problems

Source: Maryland 1975 Water Quality Inventory (5)
Maryland Department of Natural Resources

ienced occasional violations, especially in the freshwater tributaries above the Penn Central Railroad Bridge near Otter Point. Based on EPA and CBI data, the Bush River has shown consistently high concentrations of chlorophyll *a* (above 10 mg/1). Fecal coliform data, based on the Goucher study, were also occasionally above Maryland Class I Water Quality Standards (200 MPN/100 ml).

Five major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the Bush River segment of Sub-area B-1 and are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-1. Discharges from the Sod Run Sewage Treatment Plant into Romney Creek along with interceptor overflows from pumping stations along Bush Creek have resulted in increasingly eutrophic conditions in local waters. Swan Creek receives wastes from two other treatment plants, Aberdeen and Pusey (Army), and has high bacteria and chlorophyll *a* counts.

The water quality of the main tributaries to the Bush mainstem is generally good, but with high nutrients and bacteria values. The small streams are not greatly affected by these parameters and the biological life is generally good. The main influence is felt in the upstream Bush Estuary which is overenriched and showing signs of advancing eutrophication. Bathing beaches above the Penn Central R.R. Bridge were closed during the 1973 and 1974 season. Algal blooms are also increasing and may become a greater problem in the future.

The immediate needs are for extension of adequate sewer service to new areas currently experiencing septic tank failures and elimination of the overloading of interceptors which result in the discharge of raw sewage.

Swan Creek, one of the few streams which supports the Maryland Darter, an endangered species, is also in need of control of all local discharges to protect this habitat.

Overall water quality conditions in the Bush River Area, therefore, can be expected to improve as the sewage treatment plants upgrade facilities to include nutrient reduction (new discharge permits required at Sod Run and Aberdeen). Also, strict control of construction projects, and new sewerage facilities built to relieve overloading and failing septic systems will improve existing water quality conditions in the Bush River Area.

GUNPOWDER RIVER AREA

Description. The Gunpowder River Area lies in the northeast section of Maryland above Baltimore City and covers most of Baltimore County, the southwest portion of Harford County, and the northeast part of Carroll County. The boundaries of this segment, within sub-basin B-1, are shown on Plate 7-1. The area is primarily agricultural and residential, with industries and commercial establishments along the main transportation corridors, (U.S. Rt. 40, Rt. 30, Interstate 95 and 83) and a rapidly expanding urban area north and east of Baltimore as well as along Rt. 30 (Hampstead and Manchester). Main tributaries in the area are Gunpowder Falls, Little Gunpowder Falls, Little Falls, Western Run, Georges Run, Whitemarsh Run and Bird River. The Gunpowder Falls drainage area contains the Prettyboy and Loch Raven Water Supply Reservoirs which service Baltimore City with an average of 125 mgd of freshwater. "During low-flow conditions, no flow is released from the Loch Raven Dam as no permit requirement for low-flow augmentation was included at the time the dam was constructed."

Designated as Class III - natural trout waters are the Little Gunpowder Falls and all tributaries above Jarrettsville Pike, Sawmill Branch, Gunpowder Falls tributaries above and including Loch Raven Reservoir and tributaries, and the mainstem of Gunpowder Falls above Prettyboy Reservoir. Designated as Class IV - recreational trout waters are the mainstem of Little Gunpowder Falls below Jarrettsvile Pike and the mainstem of Gunpowder Falls between Loch Raven and Prettyboy Falls. All estuarine portions of tributaries in this sub-basin are designated Class II waters for shellfish harvesting, except for the Gunpowder River and tributaries above a line from Oliver Point to Maxwell Point and Middle River above a line from Log Point to Turkey Point. These and all other waters of this sub-basin are designated Class I waters for water contact and aquatic and wildlife uses.

Water Quality. Table 7-9 indicates the status of the tributaries in this segment with respect to various water quality parameters and standards developed by the State of Maryland.

TABLE 7-9
WATER QUALITY IN THE GUNPOWDER RIVER BASIN

SEGMENT	NO.	MEETS WATER QUALITY STANDARDS				COMMENTS
		D.O.	Temp.	pH	Bacteria	
Gunpowder River	(01)	Yes	Yes	Yes	Yes	Enrichment from land runoff (urban and agricultural) and discharges. High turbidity during heavy runoff
Gunpowder Falls	(02)	Yes	Yes	Yes	No	STP discharges and agricultural runoff and septic system failures. High turbidity during heavy runoff
Little Gunpowder Falls	(03)	Yes	Yes	Yes	No	Agricultural and septic system discharges and one problem industry (E. H. Tolzman, and Sons, Inc.).
Bird River	(04)	Yes	Yes	Yes	No	Urban runoff, erosion and siltation, septic system discharges. High turbidity during heavy runoff.
Middle River	(05)	Yes	Yes	Yes	Yes	Septic system areas to be sewered - urban area small bathing beach area closed to swimming (Turkey Pt.)
Browns Creek Area	(06)	Yes	Yes	Yes	Yes	Septic system areas to be sewered - urban area.
Seneca Creek	(07)	Yes	Yes	Yes	Yes	Septic system areas to be sewered - urban area.

Source: Maryland 1975 Water Quality Inventory (5)
Maryland Department of Natural Resources

The Gunpowder River mainstem generally has good water quality with some exceptions where high bacteria, nutrient concentrations and high turbidity are a problem. Dissolved oxygen, pH, temperature, and heavy metals values sampled by the Maryland Water Resources Administration (WRA) and the Annapolis Field Office (AFO) of the Environmental Protection Agency (EPA) were all within acceptable limits. Suspended solids median values, illustrating an erosion and siltation problem ranged from 18 to 32 mg/1 with extremes of 3 to 112 mg/1. Fecal coliform median values ranged from 6 to 68 MPN/100 ml, which are within Maryland Class I Standards (200 MPN/100 ml). Extreme values, however, were from less than 3 to 1,500 MPN/100 ml. Chlorophyll *a* values are 50 and 60 mg/1, indicative of high nutrient concentrations.

Only three major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the Gunpowder River segment of Sub-area B-1 and are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-1. Discharges from these treatment plants have not seriously overloaded the river, although additions of nutrients from agricultural runoff and industrial discharges have resulted in occasional algal blooms in the upper tidal area.

The main problem in the mainstem of the Gunpowder Estuary, then, is the overenrichment caused by the combination of industrial and sanitary discharges along with land and agricultural runoff. Algal blooms due to the high nutrient input from tributaries are the main concern, especially in the Prettyboy and Loch Raven Reservoir Areas. Better treatment at sanitary and industrial treatment plants is needed, specifically for nutrient removal.

Several sites below the water supply dams have shown bacteria violations which may be attributed to septic tank failures during low stream flows. Examples are Gunpowder Falls as it enters Gunpowder River and the eastern branch of Gunpowder Falls (Little Falls) near White Hall. The areas on the upper tidal portion of the Gunpowder River around Harewood Park and Oliver Beach have improved due to sewering of these beach communities and two area beaches were reopened in 1974.

The Gunpowder Area also has considerable growth and development north and east of Baltimore, and the erosion and siltation problem has become critical in many areas. A large boat population and very heavy seasonal use of the lower tidal area also adds an additional load to stressed areas.

The water quality of the Gunpowder River Area sub-basin should remain about the same in the near future. Improvements should result from the addition of advanced treatment at STP's, the sewering of large areas with faulty septic systems and the control of urban and agricultural runoff.

SUB–AREA B–2 (PATAPSCO–BACK RIVER AREA)

Description. The Patapsco River Area lies completely within the State of Maryland and consist of portions of Baltimore, Howard, Anne Arundel, and Carroll Counties as well as all of Baltimore City. Boundaries of this area are shown on Plate 7-1. The area is a highly residential and industrialized one, concentrating primarily around the major port of Baltimore. Approximately 2.1 million persons reside in the drainage area with very high population densities in the City and rapidly developing suburbs. Above the Fall Line and to the west, agricultural development and small towns dominate. Main tributaries of the area are the North, South, East, and West Branches of the Patapsco River, Gwynns Falls, Jones Falls, and the estuarine portion of Back River and Bodkin Creek.

One of Baltimore City's water supplies, Liberty Reservoir, is also located north of the Fall Line on the North Branch Patapsco River. Coastal wetlands, which are highly important to fish, waterfowl, and shellfish, total 2,734 acres in Baltimore County and 2,423 acres in Anne Arundel County. Fishery resources are also important in the Patapsco River area with 3,545 acres of fishable waters in streams and reservoirs and 22,845 acres in estuaries (12).

Designated as Class III – natural trout waters are the mainstems of Granite Branch and Mordella Branch, Jones Falls and all tributaries, Norris Run, Cooks Run, Red Run, and all tributaries above Dolfield Road, and Keysers Run. Designated as Class IV – recreational trout waters are the mainstems of the South, East, and West Branches of the Patapsco River, the North Branch of the Patapsco River above Liberty Reservoir, and Beaver Run.

TABLE 7-10
WATER QUALITY IN THE PATAPSCO RIVER AREA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	Temp.	pH	D.O.	Bacteria	
Inner Baltimore Harbor	yes	yes	yes*	no	STP wastes from Baltimore City's Patapsco River plant. Urban runoff from runoff Baltimore City. Toxic chemicals from industries. Overflowing sewers and septic tank effluents. Wastes from ships and boats including oil spills. *Exceptions: D.O. standard not met below 15' depth. D.O. standard not met in Upper Middle Branch, Stonehouse Cove and Colgate Creek. Oxygen demand by bottom sediments and/or restricted circulation resulted in D.O. depletion of bottom waters.
Outer Baltimore Harbor	yes	yes	yes*	no	STP wastes from Anne Arundel County's Cox Creek plant, and from Back Creek STP via Bethlehem Steel Company's process water. Urban runoff from Baltimore City. Overflowing sewers and septic tank effluents. Wastes from ships and boats, including oil spills. *Exceptions: Bear Creek bottom waters and Stonehouse Cove did not meet D.O. standards
North Drainage to Inner Baltimore Harbor	yes	yes	yes*	no*	Main cause of pollution is overflowing sewer lines within Baltimore City. Septic tank effluents. Urban runoff. *Exceptions: D.O. standard not met in Gwynns Falls above the mouth. Bacterial standards were met in Jones Falls and Gwynns Falls above the Baltimore City line.
North Branch Patapsco River	yes	yes	yes	no*	Wastes from farm animal concentrations. Septic tank effluents. Urban runoff from towns. STP effluents. Soil erosion from cleared land. *Exceptions: Bacterial standards were met in 2/3 of stream sampling stations, and in North Branch below [illegible]
Patapsco River	yes	yes	yes	no*	Urban runoff. Septic tank effluents. Stream bank erosion. Poor water quality entering river from South Branch. *Exceptions: Bacterial standards were met in Stoney Run.
South Branch Patapsco River	yes	no	yes	no*	Wastes from farm animal concentrations. STP discharges. Septic tank effluents. Soil erosion from cleared land. *Exceptions: Bacterial standards were met in Piney Run
Back River	yes	yes	yes*	no*	STP wastes from the Back River Baltimore City plant. Urban runoff from Baltimore City from Herring Run. Exceptions: D.O. standards were not met in area of the STP. Bacterial standards were met in lower river below Porter Point.
Bodkin Creek	yes	yes	yes*	yes*	Septic tank effluents, on-board toilet. Soil erosion at head of Wharf Creek. *Exceptions: Bacterial standards generally not met in Upper Back Creek summer diurnal D.O. depletion at mid-depth and bottom of water column probably caused by algal respiration and die-off and sediment BOD demand.

SOURCE: (5)

Water Quality. Table 7-10 indicates the status of the tributaries in this segment with respect to various water quality parameters and standards developed by the State of Maryland.

Ten major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within Sub-area B-2. These plants are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-1. Discharges of nutrients from the Back River Sewage Treatment Plant have combined with the high fecal coliform inputs of the non-tidal tributaries of Herring Run and Stemmers Run causing the Back River Estuary to become eutrophic to an undesirable degree. In the Outer Harbor from North Point to Fort Carroll and the Inner Harbor from Fort Carroll to Fort McHenry, including the Northwest and Middle Branches of the Patapsco as well as Curtis Bay, discharges from the Cox Creek and Patapsco Sewage Treatment Plants have caused DO sags and high nutrient concentrations.

Industrial discharges in the Patapsco Area are many and of varying complexities. In the harbor area alone, there are 32 major industrial dischargers (based on severity of degradation beyond the immediate locale of the outfall) and over 100 minor ones. On the average, 120 mgd of treated water is taken from the Back River Sewage Treatment Plant by the Sparrows Point Plant of Bethlehem Steel for cooling purposes. Final disposal of this effluent is into the waters of the Outer Harbor. Also, concentrations of heavy metals, which are from 3 to 50 times that of the Bay proper and directly attributable to industrial discharges and urban runoff, have caused disruption of the benthic community on the harbor's bottom. About 90 percent of this heavy metal input has been shown to be discharged by steel producing operations into Bear Creek, Old Road Bay, and the inner harbor. Several other industries discharge into the waters of the Patapsco Area other than in the harbor area. Most of these are in compliance with the effluent standards and have small discharge volumes. Although local degradations may occur around the outfalls, other sources of pollution such as agricultural runoff and sewer overflows are greater contributors to degradations in some freshwater tributaries.

Several areas within the Patapsco River Basin have experienced water quality problems for a variety of reasons. The following paragraphs will identify the major areas of concern with supplementary figures included where appropriate.

Recent surveys (1974) indicate that Inner Baltimore Harbor waters generally meet the dissolved oxygen (DO) standard near the surface and that measurements actually indicate improvement in recent years. However from the 1969-70 surveys, it was shown that the DO standard is not met at the 15-foot depth and below in the Inner Harbor proper, the Lower Middle Branch, and Curtis Bay. It was also not met at any depth in the Upper Middle Branch. Figure 7-6 illustrates the DO concentrations for surface

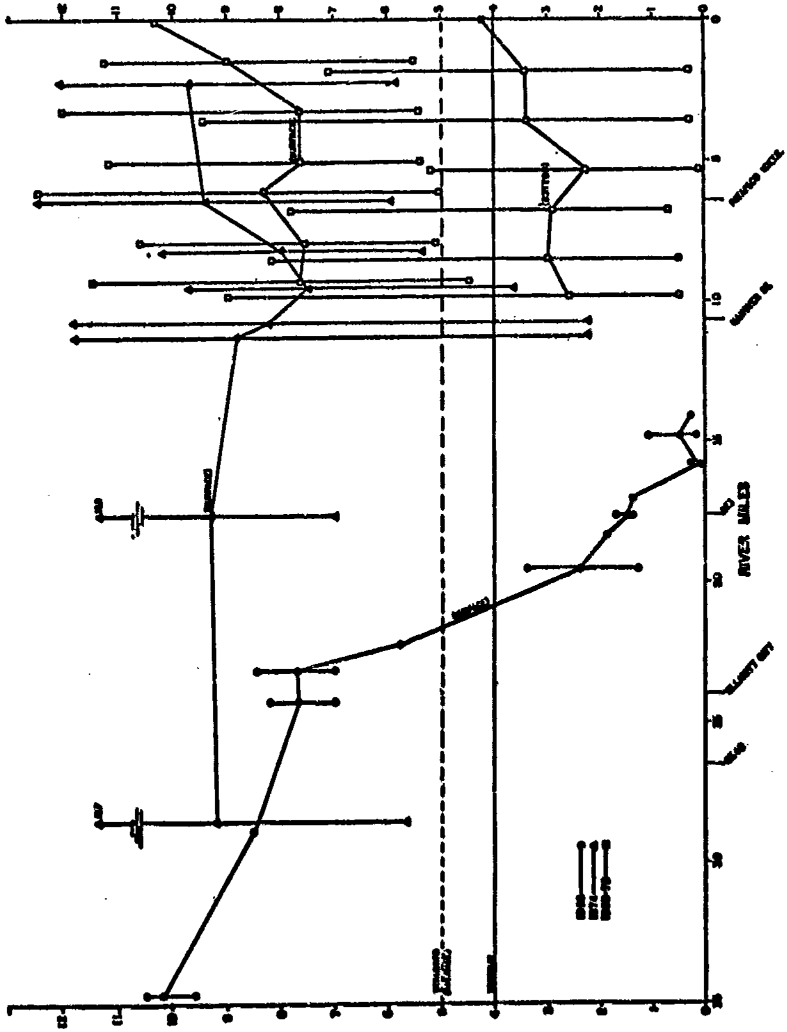


Figure 7-6: Dissolved Oxygen in Patapsco River Including Baltimore Harbor

waters of the mainstem of the Patapsco River as well as the low DO problem found in the bottom waters of the Inner Harbor. At that location the DO is depleted because of strong oxygen demand by bottom sediments and restricted harbor circulations.

Outer Baltimore Harbor waters meet the DO standard except in the deeper navigation channels and the lower depths of Bear Creek and Stonehouse Cove. The bacteria standard is not met in the upper section of this segment down to and slightly below Fort Carroll. The bacteria violations are due to overflows of raw sewage, sewer connections to storm drains, septic tank effluents, wastes from commercial and recreational boats, and urban runoff entering the harbor from city streets.

Biological studies of the harbor show that although biological support potential still exists in the harbor waters, there is environmental stress. The primary stress occurs on the harbor bottom which does not support bottom dwelling fish and clean water forms of bottom invertebrates. Bottom invertebrate samplings indicate that the inner harbor is only habitable by pollution tolerant species.

Analysis of bottom sediment in the harbor shows high concentrations of metals compared to those in Chesapeake Bay muds. Metals in the harbor sediments have the same distribution as the metal-loaded wastes which have been entering the harbor from the surrounding industrial complex. Disruption of the bottom aquatic population is correlated with the distribution of the metal laden sediments. Oysters taken from the harbor mouth and the Upper Bay were found to exceed the safe metallic content standards for shellfish.

Curtis Bay, the southern most drainage area of the Inner Harbor, does not meet DO standards at lower depths, but does neet the bacteria standard. High nutrient levels are responsible for occasional algal blooms. Bottom invertebrate and fish analyses of Curtis Bay and Curtis Creek indicate stressed conditions. Urban runoff and industrial wastes are the principal sources of pollution in the drainage area.

The North Branch Drainage of the Patapsco River does not meet bacteria standards in the majority of the stations sampled in the tributaries feeding Liberty Reservoir. Large concentrations of nutrients carried by these tributaries have made the reservoir subject to noxious algal blooms in recent years. Significant sources of pollution are septic tank effluents and farm animal concentrations above the reservoir.

Jones Falls and Gwynns Falls, the north drainage to the Inner Harbor, do not meet the bacteria standard within the confines of the City. The DO standard is also not met in the mouth of Gwynns Falls and slightly upstream. The maximum average phosphorous concentration for Gwynns Falls was 20 times higher than the maximum value for the Jones Falls. Biological analyses

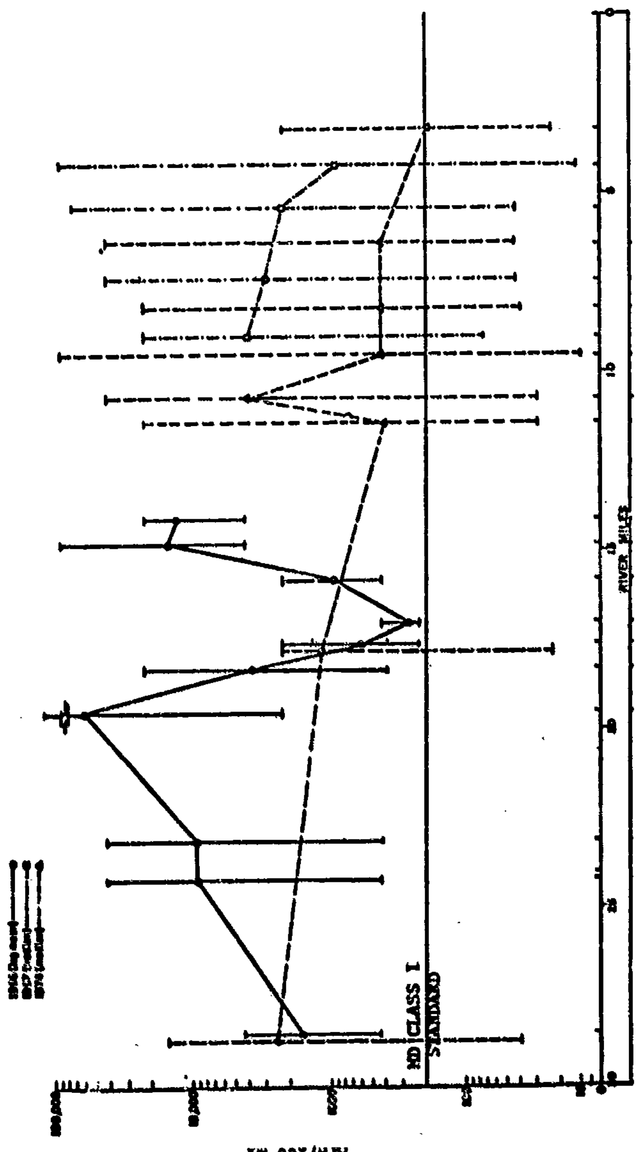


Figure 7-7: Fecal Coliform in the Patapsco River

of both streams indicate polluted conditions within the city. Overflowing sewers and failing septic tanks are the principal causes.

In the mainstem of the Patapsco River and the Inner Harbor, the bacteria standard for Class I waters is not met. Figure 7-7 illustrates the fecal coliform densities sampled in the harbor and Patapsco mainstem. Causes of poor water quality are failing septic tanks, urban runoff, and soil erosion. Water quality has improved in the mainstem below Ellicott City because of recent sewerage and industrial connections to the Patapsco Sewage Treatment Plant.

The South Branch of the Patapsco River does not meet the bacteria standard. Bacterial counts were the highest downstream from Sykesville. Sanitary wastes from septic tanks and sewage treatment plants, farm animal concentrations, and soil erosion are significant factors responsible for stream pollution.

Back River is eutrophic to an undesirable degree because of organic wastes which enter the river from the Back River Sewage Treatment Plant and non-tidal tributaries. High concentrations of nutrients are responsible for recurring noxious algal blooms.

Figure 7-8 illustrates the concentrations of nitrate nitrogen (NO_3) and total phosphorous (P) from the Back River Sewage Treatment Plant to near the mouth. Both parameters indicate increasing eutrophic conditions near the treatment plant outfall. Dissolved oxygen concentrations generally meet the standard, except in the area of the Back River Plant where occasional violations occur. The bacteria standard is met from the treatment plant to the river's mouth, but tributaries are in violation. Sources of pollution include septic tank seepage, urban runoff, and siltation from construction activities.

Bodkin Creek has supported large algal blooms during summer months. At times, dissolved oxygen concentrations are depleted below the standard in the major tributaries. This has resulted in fish and crab kills. Septic tank effluents and wastes from boats are responsible for excessive reductions in DO concentrations.

Nonpoint sources of pollution in the Patapsco sub-basin are also numerous. Raw sewage entering the Baltimore City storm drain system has contributed to poor water quality in Gwynns Falls and Jones Falls. The completion of the Southwest Diversion Project should eliminate most of the overflows to Gwynns Falls, and the overflow to Jones Falls has been reduced by the construction of the Broadway Relief Sewer. Before major improvement can be expected, however, the Patapsco WWTP will have to be upgraded to include sludge handling.

Urban runoff from Baltimore City is responsible for a large part of the

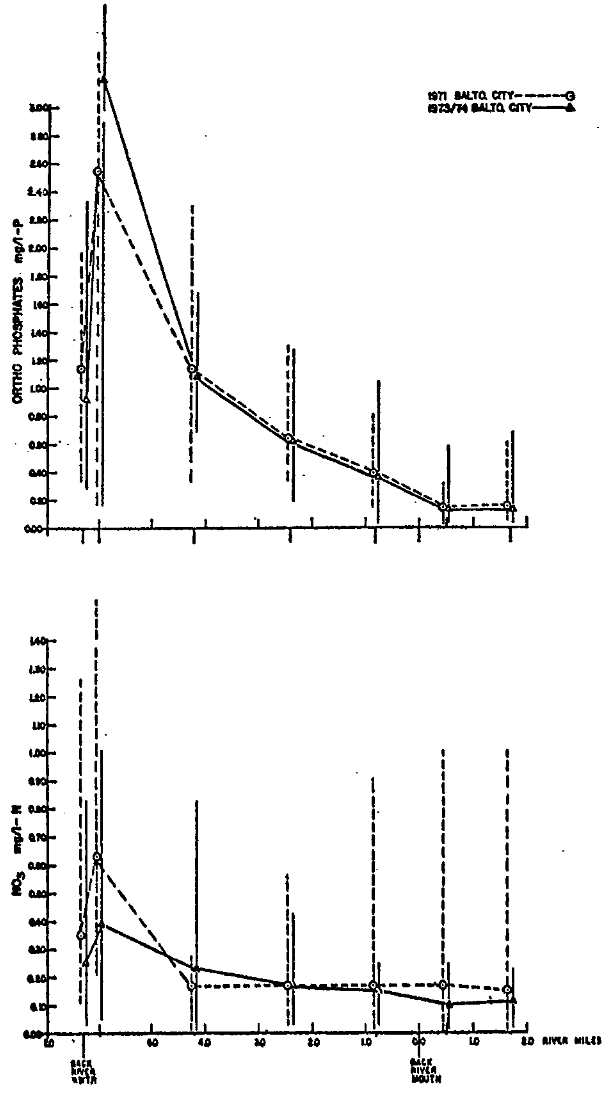


Figure 7-8: Nutrients in Back River

bacterial loading in the streams and harbor. It is also a source of oil pollution which enters the waters through storm drains.

Boats are responsible for some waste accumulation in the tidal areas of the sub-basin. Onboard toilets add sanitary wastes to the waters. Oil and liquid chemical tankers are responsible for spilled material in the harbor. In recent years, there have been approximately 25 oil spills in the harbor each year. Oil lost from the city and spilled into the harbor may amount to 3 million gallons per year.

Farm animal wastes are partially responsible for high bacterial counts and excessive nutrient loadings in the North Branch and South Branch. Large blooms of noxious algae in Liberty Reservoir are partly the result of upper watershed agricultural pollution. Pollution of the South Branch is largely the result of animal wastes entering the river.

Although improvement can be expected in some rather small river basin segments of sub-area B-2, the large concentration of industry and increasing residential growth will continue to stress the waters of the region. The Southwest Diversion Project to the Patapsco Sewage Treatment Plant, controlled development in the Baltimore County section of the watershed, consolidation of several small treatment plants in the Sykesville Area, and permits issued to industrial dischargers in the Harbor area will improve quality to some extent. However, lack of adequate treatment capacities at the Cox Creek and Patapsco Sewage Treatment Plants, large volumes of industrial discharges in the Harbor area, and advancing eutrophic conditions in Back River and the Liberty Reservoir will probably continue to cause major problems within the entire sub-basin and should be monitored carefully to prevent further degradations. In addition, the proposed disposal site for dredged material from Inner Baltimore Harbor at the Hart and Miller Islands has created, and will continue to be, a major concern of citizens and water quality managers in the area. This site, which is located north of the mouth of the Patapsco River in Chesapeake Bay proper, is currently scheduled to contain the heavy metal laden bottom sediments of the Inner Harbor from both the 50-foot channel project and maintenance dredging. With the sediments enclosed in a diked area approximately 1,100 acres in size, the adverse water quality effects on Chesapeake Bay are not expected to be great over the life of the project.

SUB-AREA B-3 (PATUXENT-WEST CHESAPEAKE)

This sub-basin encompasses the Patuxent and West Chesapeake Bay Basins, located between Baltimore and Washington on the Western Shore of Maryland. Following is a description of existing water quality conditions for both segments as summarized from the 1975 Maryland Water Quality 305(b) Report (5) and the Patuxent 303(e) Water Quality Management Plan (7).

WEST CHESAPEAKE BAY AREA

Description. The West Chesapeake Bay Area lies along the Western Shore of Maryland between the major cities of Baltimore and Washington, D.C. As shown on Plate 7-1, Anne Arundel and Calvert Counties as well as the city of Annapolis are included in this segment. The area is characterized by rolling uplands broken by several sub-estuaries with small amounts of freshwater inflow. Due to the proximity to Washington and Baltimore, the northern portion of the area (above South River) is the most densely populated. Shoreline along the Bay varies from a few feet to about 100 feet in height and is easily eroded.

Major tributaries and sub-estuaries in the area are the Magothy, Severn, South, Rhode, and West Rivers. Flushing of the waters in these rivers is accomplished mainly by density differences with the waters of the Bay and by other effects such as high winds, atmospheric pressure, and by the usual tidal flushing. Time periods for these exchanges vary from days to months.

Severn Run and all tributaries above Route 3 are designated Class IV waters for recreational trout. All estuarine portions of tributaries in the West Chesapeake Area sub-basin are designated Class II waters for shellfish harvesting, except the Magothy River and tributaries above Henderson Point, Severn River and tributaries above the mouth of Forked Creek, South River and tributaries above Porter Point, Rockhold Creek and tributaries above Masons Beach Road, and Tracys Creek above Route 256. These and all other waters of this sub-basin are designated Class I waters for water contact and aquatic and wildlife uses.

Water Quality. In the West Chesapeake sub-basin, water quality is generally acceptable for water contact recreation and aquatic life uses. Table 7-11 indicates the status of segments in this sub-basin with respect to selected water quality parameters. Only the shellfish harvesting standard is exceeded in certain areas. Attachment 7-B lists the shellfish areas within the West Chesapeake Area which were closed as of December 31, 1974. Also included is an update of closings effective March 31, 1976.

Eleven major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the West Chesapeake segment of Sub-area B-3. These plants are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-1, at the back of this appendix. Discharges from these plants have not themselves caused severe degradations, although some naturally occurring stressed areas are in the vicinities of their outfalls. The water quality problems become magnified, especially during the summer months when the estuarine waters stratify and hold nutrient and bacterial loads in suspension.

Scattered industrial dischargers are also found in the West Chesapeake Bay Area. Most of these are small, causing only local degradation of water

TABLE 7-11
WATER QUALITY IN THE WEST CHESAPEAKE ARRA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS[2]
	D.O.	Temp.	pH	Bacteria[1]	
Magothy River	yes	yes	yes	*	Bacterial values exceed standard in some small tributaries and Lake Waterford.
Severn River	yes	*	yes	*	Bacterial values exceed standard in Severn Run, the upper estuary and the vicinity of Annapolis. Temperature exceeds standard in Severn Run from industrial cooling waters and/or natural causes from physical location.
South River	yes	yes	yes	*	Shellfish harvesting prohibited upstream of Ferry Point and three creeks, bacterial values would be acceptable for water contact recreation.
West-Rhode	yes	yes	yes	*	Upstream areas and Parrish and Cadle Creeks not acceptable for shellfish harvesting.
Other Drainage	yes	yes	yes	*	Rockhold Creek not acceptable for shellfish harvesting.
Beverly Beach Area	-	-	-	-	No data.
Bay Ridge Area	yes	yes	yes	*	Fishing Creek and Lake Ogleton closed to shellfish harvesting.
Broadneck Area	yes	yes	yes	*	Bacterial values in Mill and Whitehall Creeks exceed numerical standards.
Pinehurst-Gibson	-	-	-	-	No data.

Source: (5)

quality. A chemical company, however, discharges approximately 1.5 mgd of cooling water to Severn Run near Odenton, causing occasional violations of the water quality standards for natural trout streams during periods of low flow. The Calvert Cliffs Nuclear Generating Station, located near Lusby in Calvert County, is also located in this area. Opening early in 1975, this plant, which was designed for two 875 megawatt units requiring approximately 2,950 mgd of water intake, has become a source of heated water to the Bay. Physical, chemical, and biological monitoring at this site has been extensive and will be continued in order to determine the various impacts upon the surrounding area.

Of the waters classified for shellfish harvesting, sixty percent meet standards while forty percent do not. The areas in violation are: the Severn River from Forked Creek to Round Bay and the area near Annapolis; the portion of South River upstream of Ferry Point and three tributary creeks; the upstream of Cox Creek and Parish Creek; and several small creeks tributary to the Chesapeake Bay. However, most of these prohibited areas do meet the standards for water contact recreation.

Bacteria values in excess of the applicable standards are found in many of the headwaters and near dense population centers, particularly at times of heavy rainfall. Since few treatment plants are located in the sub-basin, the major source of this bacteria is believed to be from such nonpoint sources as urban stormwater runoff, agricultural runoff, and faulty septic systems. A major portion of the bacteria found in the waters bordering the City of Annapolis has been attributed to storm water runoff.

Nutrient concentrations have shown an increase in the last ten years.

Available data show the average phosphate value to have increased tenfold in a ten year period in the Severn River accompanied by a doubling of the average chlorophyll *a* content. South River data show more variability in phosphate levels, but generally a larger average value that in the Severn River, accompanied by a greater increase in average chlorophyll *a* in the same period. The above is borne out by more frequent and concentrated algal blooms being observed in the South River than in the Severn. Similar algal blooms have occurred throughout the West Chesapeake sub-basin but with less frequency and intensity than in the South and Severn Rivers.

Urban-suburban runoff and failing septic systems in the South, West, and Rhode River Areas are the major nonpoint sources of high bacteria counts. Construction and agricultural practices have also caused rapid sedimentation in some areas. This results in increased turbidity, destruction of benthic communities and fish spawning grounds, and in the filling of navigable waterways. Many of the headwaters which once supported baywide shipping are no longer navigable, even for small craft.

Water quality conditions can be expected to improve in the West Chesapeake sub-basin in the near future. Most improvements will result from the Maryland Water Resources Administration Policy for point source discharges or requirements arising out of the 303(e) State Basin Plan for this area. However, urban storm water runoff will still continue to cause high bacteria counts in the areas adjacent to the City.

PATUXENT RIVER AREA

Description. The Patuxent River, largest intrastate river in Maryland, flows between the two metropolitan areas of Washington and Baltimore. Originating at the junction of Howard, Montgomery, Frederick, and Carroll Counties, it flows southeasterly to the confluence with Chesapeake Bay at Solomon's Island. The mainstem of the river forms a boundary between, and includes parts of Howard, Anne Arundel, and Calvert Counties on the north and east, and Montgomery, Prince Georges, Charles, and St. Marys Counties on the south and west. The actual boundaries of this area are shown on Plate 7-1.

Presently, over 50 percent of the basin is forested, about 35 percent is agricultural, and the remaining 15 percent is classified as urban land use. The upper reaches of the watershed consists of increasing residential and industrial urban centers surrounded by agricultural land. Major towns and cities in the area are Columbia, Laurel, Bowie, Lanham, and Savage. The largest tributary is the Little Patuxent River, which joins the mainstem at Bowie.

Two water supply reservoirs (Triadelphia and T. Howard Duckett), with a combined storage capacity of 13.4 billion gallons and a dependable yield of

40-50 mgd, are near the headwaters of the Patuxent at Laurel. Water is exported from these reservoirs for use by Washington Suburban Sanitary Commission (WSSC) in Montgomery and Prince Georges Counties. The WSSC permit requires a continuous release of 13.5 cfs to maintain river flow at Laurel.

The Patuxent River and all tributaries above T. Howard Duckett Reservoir are designated Class IV - recreational trout waters. All estuarine portions of the Patuxent River and tributaries below Ferry Landing are designated Class II waters for shellfish harvesting. All other waters of this sub-basin are designated Class I waters for water contact and aquatic and wildlife uses.

Water Quality. Investigations have been conducted in the Patuxent River over the past twenty years with some fairly intensive sampling in the late 1960's and early 1970's. Table 7-12 indicates the status of the segments in this sub-basin with respect to selected water quality parameters and standards developed by the State of Maryland. Shellfish waters are currently closed from about river mile 20.4 upstream to Ferry Landing (about river mile 40). This and all the other closures as of March 31, 1976 are listed in Attachment 7-B, at the back of this Appendix.

Early water quality studies showed degradations within the Patuxent Basin during periods of high temperature and low flow. Violations of DO were frequently recorded in the 15 mile reach of the river below Laurel. Bacterial violations were also recorded during the critical summer period at points in the upper, middle, and lower reaches of the mainstem Patuxent. More recent findings show some improvements in average D.O. levels in the middle region (river mile 60 to 74) with occasional violations recorded. However, between river mile 60 and 30, average D.O. values, although above standards, have reduced from previous levels. From river mile 70 downstream to mile 20, average values of total phosphorous and inorganic nitrogen have both shown significant increases over previous levels. Fecal coliform bacteria standards are exceeded in most portions of the middle section of the mainstem and in the tidal reaches.

Eighteen major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the Patuxent River segment of Sub-area B-3. These plants are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-1, at the back of this appendix.

Industrial discharges in the basin are minimal. Those industries that do lie in the area are generally small operations. The largest industrial discharger in the basin is the Potomac Electric Power Company Chalk Point Electric Plant, which discharges approximately 720 mgd of cooling water to the river. Although the main concern is thermal pollution and tidal portions of the estuary presently do not meet Class II temperature standards, studies to date have not determined that problems are being created by this high volume of heated effluent.

TABLE 7-12
WATER QUALITY IN THE PATUXENT RIVER BASIN

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Patuxent River Mainstem	*	yes	yes	*	*DO's less than and bacterial levels in excess of numerical standards with high nutrient and chlorophyll levels in 40-50 mile river reach from municipal WWTPs.
Western Branch Drainage	yes	yes	yes	*	*Bacterial levels in excess of numerical standards throughout most of drainage area--sources not defined--land runoff or septic tank failures.
Little Patuxent Drainage	*	yes	yes	*	*DO's less than and bacterial levels in excess of numerical standards recorded in portions of Little Patuxent River and tributaries associated with WWTPs and runoff.
Middle Patuxent Drainage	yes	yes	yes	*	*Recorded levels of bacterial in excess of numerical standards associated with land runoff and failing septic systems.
Patuxent-Chesapeake Bay Drainage	yes	yes	yes	*	*Occasional recorded levels of bacteria in excess of numerical standards in Pine Hill Run and St. Jerome Creek. Quality generally good.
Patuxent River-East Area Drainage	yes	yes	yes	*	*Bacterial levels in excess of numerical standards recorded. Battle Creek, Island Creek, Back Creek and Hill Creek currently closed to shellfishing from runoff or septic tank problems.
Patuxent River-Southwest Drainage	yes	yes	yes	*	*Bacteria levels in excess of numerical standards recorded in some tributaries. Persimmon Creek, Washington Creek, Trent Hall Creek and all tribs above this point are closed to shellfishing.
Patuxent River-West Area Drainage	-	-	-	-	Water quality data lacking for streams in this segment. Bacterial levels in excess of numerical standards and high nutrients have been recorded in adjacent river.
Patuxent River Headwaters Area Drainage	yes	yes	yes	*	*Some recorded bacterial levels in excess of numerical standards. Urban and rural runoff sources.

Source: (5)

Increases in urban and suburban development in the Patuxent River sub-basin have combined with low and sluggish summer flows to degrade water quality in large segments of the river dowstream from wastewater sources (river mile 30 to 45). Oxygen depletion, bacterial contamination, sedimentation, and eutrophication are all symptomatic of the land use changes the basin is undergoing and their effects will continue to increase in downstream reaches as development continues in the Patuxent River sub-basin.

Biodegradable, organic constituents in municipal wastewater discharges located in the upper part of the basin have caused depressed dissolved oxygen conditions in the nontidal portion of the river during the summer low flow conditions. Analysis of long term water quality data reveals that the nitrogen fractions of the wastewater (ammonia and organic nitrogen) are the major components of the oxygen depleting material discharged by the various wastewater treatment plants. The Parkway Wastewater Treatment Plant at river mile 74.6 has recently added a nitrification process which will convert the ammonia and organic nitrogen fractions to nitrites and nitrates within the plant, removing these oxygen demanding fractions from the mainstem and allowing the maintenance of acceptable DO levels downstream. Unfortunately, this conversion does not decrease total nitrogen available for algal blooms as phosphorous is now considered to be the limiting nutrient in the Patuxent Mainstem.

Bacterial contamination in excess of standards is found in localized areas throughout the basin, most directly attributable to agricultural and/or urban runoff. However, existing wastewater treatment facilities and other point source wastewaters may still account for some of the contamination. Direct economic impact associated with violations of bacterial standards is most pronounced in the Patuxent River Estuary, an important oyster harvesting area.

Procedures that have been established over the past few years for improved sediment control have been instrumental in reducing sediment reaching the Patuxent River. It is expected that the future will see much greater reductions in sediment reaching the River. Sedimentation has been and continues to be a problem of major importance in this sub-basin as navigable areas have been significantly limited through the years by sediment deposition.

Degraded water quality conditions in the Patuxent River can be expected to worsen as the population increases, unless a greater degree of wastewater treatment is provided or other methods of wastewater management (such as land treatment, recycling or diversion out of the basin) are adopted. Although the proper management of municipal wastewater cannot in itself be expected to solve all the water quality problems in the basin, such management can be expected to improve the river water quality so that dissolved oxygen water quality standards can be met and serious eutrophication problems in the estuary can be averted. The quality of the water, as indicated by the coliform bacteria criteria, can also be expected to improve with the proper management of municipal wastewater discharges. Unfortunately, nonpoint sources of coliform organisms (e.g., agricultural drainage and urban stormwater runoff) will probably continue to cause problems until practical solutions for such sources can be found.

STUDY AREA II–POTOMAC

The Potomac Study Area contains 3 sub-areas designated for this study as P-1, P-2, and P-3. These sub-areas were formed from the major river basins in the area as shown in Table 7-1. Study Area II lies within and is under the jurisdiction of the State of Maryland and Virginia as well as the District of Columbia. The boundaries are shown on Plate 7-2, which is at the back of this appendix. The information presented in this section was obtained from the Maryland Water Quality 1975 305(b) Report (5), the Virginia Water Quality 1975 305(b) Report (13), the Potomac-Metropolitan (14) and the Potomac-Shenandoah (15) 303(e) Water Quality Management Plans.

SUB-AREA P-1–(WASHINGTON METROPOLITAN AREA)

Description. The Potomac River, second largest contributor of freshwater to Chesapeake Bay, flows between and acts as a natural boundary for the States of Maryland, Virginia, and West Virginia. From the headwaters of the North Branch in West Virginia to its mouth at Chesapeake Bay, the river flows approximately 400 miles and drains approximately 14,700 square miles of land in the states of Virginia, Maryland, West Virginia, and Pennsylvania and the District of Columbia. The portion of the Potomac within sub-area P-1 extends from approximately river mile 135 near Seneca Creek to approximately river mile 85 near Marshall Hall, including 50 percent of Prince Georges and 80 percent of Montgomery Counties as well as all of the District of Columbia. The boundaries of this region are shown on Plate 7-2.

The area is characterized by very heavy urbanized development with some agricultural and wooded lands near the headwaters of the freshwater tributaries. In addition to the Washington D.C. Metropolis, other cities in the area are Gaithersburg, Rockville, Silver Spring, and College Park. Main tributaries in the area which discharge to the Potomac Mainstem are Seneca Creek, Muddy Branch, Cabin John Creek, Rock Creek, Anacostia River, and Piscataway Creek.

The Washington Suburban Sanitary Commission (WSSC) supplies Montgomery and Prince Georges Counties with water from the mainstem of the Potomac. The appropriation permit for the intake (located above Great Falls in the vicinity of Watts Branch) allows for an average withdrawal of 350 mgd. Currently, the system withdrawals average approximately 85 mgd.

Paint Branch and all tributaries above the north crossing of Capital Beltway I-495 are designated Class III – natural trout waters. Little Seneca Creek and all tributaries, and Rock Creek and all tributaries above Route 28 are designated Class IV – recreational trout waters. All other waters of the Washington Metropolitan Area sub-basin are designated Class I waters for water contact recreation and aquatic and wildlife uses.

Water Quality. Due to the importance of the Potomac River as a water

TABLE 7-13
WATER QUALITY IN THE WASHINGTON METROPOLITAN AREA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Main Stem	*	yes	yes	no	Bacterial values exceed standard due to inadequate waste treatment and urban and agricultural runoff. DO low in estuarine portion near D.C.
Piscataway Creek	*	yes	yes	no	Bacterial values exceed standard due to inadequate waste treatment and urban and agricultural runoff. Low DO values at times of dense algae bloom die off.
Anacostia River	*	yes	yes	no	Bacterial values exceed standard due to urban-suburban runoff and overflowing sewers. Low DO values reported, in D. C. area.
Rock Creek	yes	yes	yes	no	Bacterial values exceed standard due to urban runoff and overflowing sewers.
Bryan Point	-	-	-	-	No data.
Seneca Creek	yes	yes.	yes		Bacterial values exceed standard due to urban and agricultural runoff.
Washington D.C.-South	-	-	-	-	No data.
Washington D.C.-Central	-	-	-	-	No data.
Rockville-Bethesda	yes	yes	yes		Bacterial values exceed standard due to urban runoff inadequate sewage treatment, and overflowing sewers.
Poolesville	-	-	-	-	No data.
Virginia Area	-	-	-	-	No data. Drainage from State of Virginia.

SOURCE: (5)

supply for the Washington Metropolitan Area as well as recreational uses, extensive water quality data has been collected by various Federal, State, and local agencies. Table 7-13 indicates the status of the segments in this sub-basin with respect to selected water quality parameters and standards developed by the State of Maryland. Table 7-14 indicates the major pollution problems and trends of the Potomac Mainstem and all its tributaries within the entire Potomac Study Area as obtained from the 1962-1973 water quality study by the Interstate Commission on the Potomac River Basin (ICPRB).(3)

In the mainstem of the Potomac from below Great Falls downstream to Marshall Hall and the mouth of Piscataway Creek, the quality of water begins to degrade. At Great Falls, site of the WSSC water intake, water is generally of good quality. Nutrient concentrations, BOD_5, DO, and temperature measurements were all within acceptable limits from 1962-1971. Occasional exceedence of the 8.5 pH standard indicates, however, an increasing trend toward basic waters. Below the Blue Plains Sewage Treatment Plant, the waters begin to show severe degradations although general improvement has been indicated due to improved sewage treatment practices. Values for water temperature (1-30.5°C), turbidity

TABLE 7-14
MAJOR WATER QUALITY PROBLEMS--POTOMAC RIVER BASIN

Stream Segments	Major Pollution Problem Identified	Water Quality Status Estimate	Composite 1962-1973 Trend Analysis
Potomac River—Main Stem			
Luke to Cumberland (North Branch)	A_1, O, I, H.	Poor	↓
Cumberland to Williamsport	No Data	Good	→
Williamsport to Great Falls	O, B, I	Good	→
Upper Estuary to Blue Plains	O, B, N	Fair	↓
Blue Plains to Indian Head	O, B, N	Poor-Fair	↑
Indian Head to Maryland Point	O, N	Fair-Good	↑
Maryland Point to Mouth	No Data	Good-Excellent	→
Monocacy River	O, B, T	Good	↓
Goose Creek	B, A_2	Fair-Good	↓
Seneca Creek	B, T	Fair	↓
Muddy Branch	B, T	Fair	↓
Cabin John Creek	O, B	Poor-Fair	↓
Potomac Estuary Tributaries			
Rock Creek	O, B, T	Poor-Fair	↓
Anacostia River	O, B, I, T	Poor-Fair	↑

↑ = improvement ↓ = deterioration → = status quo

A_1 = Acidic water
A_2 = Alkaline water I = Inorganic Wastes (minerals, etc.)
O = Organic Wastes (biodecomposable) H = Heated Wastes
B = Bacterial Contamination T = Turbid Water
N = Nutrients

Source: (3)

(6-255 JTU), alkalinity (23-142 mg/l) and pH (6.8-8.3) should support good fisheries. However, the D.O. minimum (less than 4 mg/l), BOD_5 maximum (14.1 mg/l), and the fecal coliform density (1,100,000 MPN/100 ml) have rendered the waters unsuitable for the maintenance of aquatic life and recreation.(3) Figure 7-9 depicts total coliform concentrations and Figure 7-10 indicates the number of all DO measurements violating Water Quality Standards below the Blue Plains Sewage Treatment Plant. Ten miles downstream at Marshall Hall, improved conditions are evident although poor-fair conditions are still prominent. High concentrations of phosphorous and other nutrients continue to be a problem as shown by a 0.370 mg/l concentration of phosphorous in 1970, four times the concentration reportedly needed for algal blooms to occur in streams.

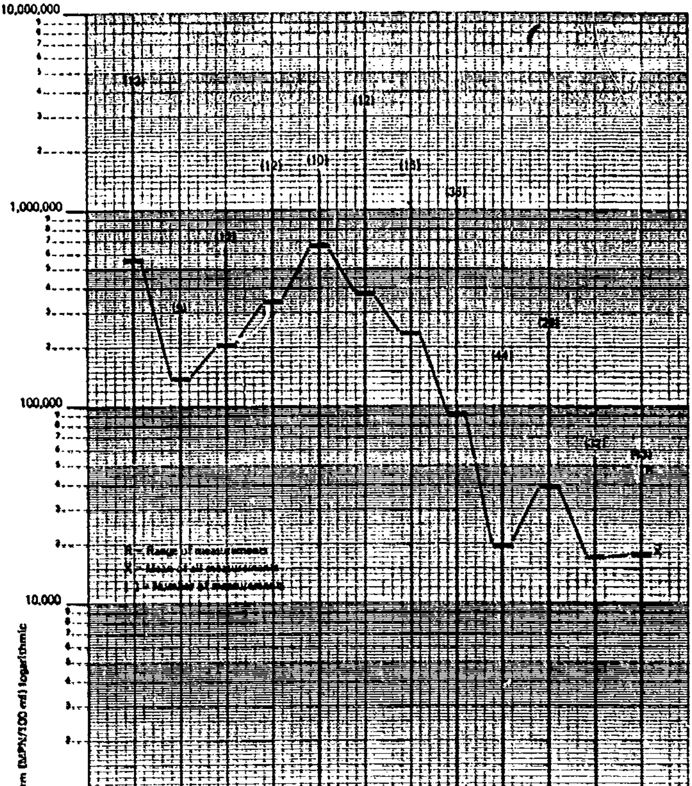


Figure 7-9: Total Coliform Below Blue Plains STP, Wash., D.C. 1962-1973

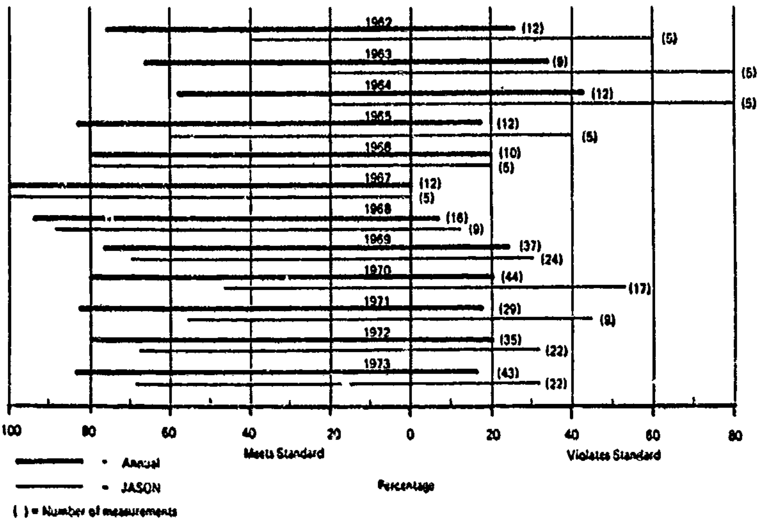


Figure 7-10: The Number of DO Measurements (%) Violating the Water Quality Standard Below Blue Plains STP, Washington, DC, River Mile 95.3 on the Freshwater Potomac Estuary for 1962-1973.

Source: (3)

The tributaries of Seneca Creek, Muddy Branch, Cabin John Creek, Anacostia River, and Rock Creek have shown poor to fair water quality conditions. High nutrient and bacteria concentrations as well as excessive sediment loads have contributed greatly to the existing degraded conditions in the mainstem.

Fourteen major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the Washington Metropolitan Area. These plants are listed along with the current discharge loadings in Attachment 7-A. Included is the Blue Plains Sewage Treatment Plant, largest municipal plant in the Bay Area. The locations of each plant are presented on Plate 7-2, at the back of this appendix. Because of high discharge volumes, especially at the Blue Plains STP (average flow 280 mgd), the municipal dischargers have been designated as major contributors to water quality problems in the area.

Industrial discharges are significantly less than in the Baltimore Area and consequently are not considered as major contributors to the degradation of water quality in the area. Two electric power plants, one at Dickerson on the mainstem and the other on the Anacostia River, are operated by the Potomac Electric Power Company (PEPCO) and discharge high amounts of

cooling water causing significant temperature increases at the outfalls. Sand and gravel dredging operations near the mouth of Piscataway Creek are sources of high sediment loads and turbidity to the Potomac. Other industries are generally small and several within the boundaries discharge directly into public sewers.

Pollution problems occur throughout the Washington Metropolitan Area sub-basin, with two distinct causes. The first of these, urban and/or agricultural runoff, causes high fecal coliform counts and high nutrient loadings in nearly all segments. The second, wastewater treatment plant effluents, causes severe oxygen depressions in the mainstem and tidal embayments and further increases nutrient loadings.

Although bacteria densities are less than pre-1966 levels, possibly, due to more effective chlorination, the levels are sufficiently high such that the bacteria standard is not met upstream of Indian Head in the estuarine portion of the Potomac.

Better than 100,000 pounds per day of nutrients pass from upstream sources over Great Falls into the upper estuary and another 84,000 pounds per day are added by 14 major sewage treatment plants (STP's) within the sub-area. This loading exceeds that which the Potomac River can accept and still maintain a balanced environment. Problems are illustrated by massive blooms of blue-grass algae in the upper estuary and depressed dissolved oxygen conditions.

Tributaries such as Seneca, Cabin John, Rock, and Piscataway Creeks, and the Anacostia River contribute high nutrient, bacteria, and sediment loads to the Potomac. The sources of these loads are storm water runoff, inadequate waste treatment, and/or sewage system overflows.

In the Potomac Estuary, another major water quality problem is that of sediment pollution. In 1972, over three million tons of sediment were discharged into the estuary. High concentrations of suspended solids may at times be a limiting factor with regard to algal blooms by blocking out the needed sunlight. The deleterious effects of sedimentation, however, far outweigh any beneficial factors relative to the reduction of algal blooms.

SUB-AREA P-2–LOWER POTOMAC RIVER AREA

Description. The Lower Potomac sub-basin is approximately 86 miles in length from Marshall Hall, which is the downstream limit of sub-area P-1, to the mouth. River widths vary from one mile at the northern boundary to six miles at the mouth, while the average depth of approximately 100 feet exists near Morgantown. Boundaries of this region, which include the Maryland Counties of Charles and St. Marys, are shown in Plate 7-2.

The area is characterized by rural developments with low density popula-

tions, agricultural lands, and a few widely scattered towns. Major tributaries include St. Marys River, Wicomico River, Port Tobacco River, Nanjemoy Creek, and Mattawoman Creek. The main source of water exchange in these tributaries, however, is supplied by the Potomac itself. Density differences act as the main driving force, the tributary waters having a net outflow on the surface and inflow on the bottom when mainstem waters have higher densities (higher salinity). High winds can also cause swift exchange depending upon direction and duration.

Fair to good sport fishing is found throughout the sub-basin. The estuarine portion, from Maryland Point to the Bay, supports a large variety of aquatic life and provides primary recreational opportunities. Striped bass, or rockfish, are the most commercially valuable fish found in the estuary. Important spawning areas in the region are found in the vicinity of the freshwater/saltwater interface which is located between Piscataway Creek and Nanjemoy Creek. Another important commercial resource, blue crabs, are also found in the lower basin. Taken by pots, trout lines, scrapes, dip nets, and traps from April 1 to December 31, blue crabs are found as far up the estuary as Piscataway Creek.

Water Quality. The water quality throughout this section of the Potomac Basin is generally good to excellent. Table 7-15 indicates the status of the segments in this sub-basin with respect to selected water quality parameters and standards developed by the State of Maryland. Major pollution problems and trends in the Lower Potomac Mainstem, for the sections from Marshall Hall to the mouth, are identified in Table 7-14 which is presented in the Washington Metropolitan Section of this chapter. Several shellfish waters have been closed in this area as of 31 March 1976. These areas are listed in Attachment 7-B.

Thirteen major municipal treatment plants (average flows greater than 0.1 mgd) are within the Lower Potomac Area. These plants are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented in Plate 7-2, at the back of this appendix. Discharges from these plants are generally small and have caused only local degradations in some of the freshwater tributaries.

Industrial discharges in the basin are generally small and have little impact upon the quality of water in the basin. However, accidental oil spills from the Steuart Petroleum Storage Facilities at Piney Point occur from time to time, especially during the loading and unloading of ships and barges. The PEPCO Power Plant at Morgantown, near the eastern end of the U.S. Route 301 Bridge, discharges cooling water into the mainstem and studies by the Maryland Department of Natural Resources are currently underway to determine the effects of the heated discharges.

TABLE 7-15
WATER QUALITY IN THE LOWER POTOMAC AREA

SEGMENT	MEETS WATER QUALITY STANDARDS D.O.	Temp.	pH	Bacteria[1]	COMMENTS
Main Stem	yes	yes	yes	*	St. Catherine Sound closed to shellfish harvesting. Occasional oil spills from Steuart Petroleum at Piney Point. High nutrients and algae population in upper reaches.
St Mary's River	yes	yes	yes	*	Tidal area upstream of Church Point closed to shellfish harvesting.
St. George's Creek	yes	yes	yes	*	Schoolhouse Branch and Locust Grove Cove closed to shellfish harvesting.
Breton Bay	yes	yes	yes	*	Tidal area upstream of Chevy Cove closed to shellfish harvesting.
St. Clement Bay	yes	yes	yes	*	Canoe Neck Creek, St. Patrick Creek and tidal area upstream of Miley Creek closed to shellfish harvesting. Bacterial values exceed standard values in nontidal water upstream of U. S. G. S. gage.
Wicomico River	yes	yes	yes	*	Chaptico Bay, Charleston Creek, Dolly Boarmans Creek, and tidal area upstream of Barber Point closed to shellfish harvesting. Bacterial values exceed standard values in Chaptico Dreek at U. S. G. S. gaging station.
Gilbert Swamp	yes	yes	yes	no	Bacterial values exceed numerical standard values.
Zekiah Swamp	yes	yes	yes	no	Bacterial values exceed numerical standard values.
Port Tobacco	yes	yes	yes	*	Bacterial values exceed numerical standard values at head of tidal waters and in non-tidal waters. Area adjacent to Chalk Point closed to water contact recreation.
Nanjemoy Creek	yes	yes	yes	*	Bacterial values exceed numerical standard in Mill Run and non-tidal portion of Nanjemoy Creek.
Mattawoman Creek	*	yes	yes	*	Bacterial and D.O. values exceed numerical standards in the non-tidal portion.
Potomac River Mouth	yes	yes	yes	*	Upstream portions of Smith Creek and Jutland Creek closed to shellfishing.
Huggins Point	yes	yes	yes	*	Herring Creek closed to shellfish harvesting. Occasional oil spills from Steuart Petroleum at Piney Point.
White Neck Point	yes	yes	yes	*	White Neck Creek closed to shellfish harvesting.
Morgantown	yes	yes	yes	*	Neal Sound closed to shellfish harvesting.
Cedar Point	yes	yes	yes	yes	
Chickamuxen Creek	-	-	-	-	No data.
Potomac Heights	-	-	-	-	No data.

Source: (5)

The Washington Metropolitan Area waste loadings, though not directly located in this sub-basin, are considered the major source of water quality degradation in the area. Waste loads from Blue Plains along with other point and non-point sources upstream must decrease before water quality in this segment can improve.

In the mainstem from Indian Head to Maryland Point, bacteria populations are decreasing, perhaps due to more effective chlorination at the Blue Plains Wastewater Treatment Plant. High nutrient concentrations are received from the Washington Region with attendant heavy blooms of blue-green algae in the upper portion. Excessive nutrients from sewage treatment plants (STP's) discharging into embayments and creeks such as Piscataway Creek and Occoquan Bay cause nuisance algal blooms, sometimes reaching as far downstream as the Morgantown Area.

Water quality at Smith Point, Maryland, is generally quite good, with only occasionally high values for BOD. Downstream of Smith Point, Maryland, water quality becomes excellent in the mainstem. However, closure of restricted local areas to shellfishing around the location of small sewage outfalls is still necessary.

From Maryland Point to the mouth of the River, the water quality remains good to excellent. Portions of some tributaries are closed to shellfish harvesting. However, these portions are not as extensive as in the past.

The freshwater tributaries themselves generally meet temperature, pH, and dissolved oxygen standards. High bacteria counts, however, are still found in most of the tributaries. Related causes are agricultural and urban runoff along with seasonal additions of municipal sewage. Occasional dissolved oxygen sags during the summer low flow months also occur in the Port Tobacco River and Mattawoman Creek.

In conclusion, the present water quality in most of this sub-basin is excellent. Reductions of nutrient loadings from the Washington Area should improve the eutrophic conditions now found in the upper portion of the sub-basin's mainstem. Control of agricultural and urban runoff in the tributaries will be necessary before significant improvement in bacterial levels can be expected.

SUB-AREA P-3 (NORTHERN VIRGINIA AREA)

Description. The Northern Virginia sub-basin is located in the northern tip of the Commonwealth of Virginia along the Potomac River Mainstem from just below the confluence of the Shenandoah River at the Virginia-West Virginia border to the mouth of the river at Chesapeake Bay. Boundaries of this region include Virginia State Planning Districts 8, 16, and 17, which comprise all or parts of the Counties of Loudoun, Fairfax, Prince William, Arlington, Stafford, King George, Westmoreland, and Northumberland. This area is shown on Plate 7-2. Only the tributaries within the State of Virginia are covered in this section, as discussion of the Potomac Mainstem is included in sub-areas P-1, Washington Metropolitan, and P-2, Lower Potomac, of this report.

The area near the Potomac Estuary is characterized by a heavily populated and rapidly expanding urbanized type of development. Nearly two-thirds of the sub-area's total population is concentrated within a 15 mile radius of Washington, D.C., while the sparsely populated areas lie to the south and northwest. Government is the most important employer in the metropolitan area with banking, research, and the manufacture of scientific and technical equipment of secondary importance. Commercial fishing in the lower estuary areas yields an annual average of 2.6 million pounds of finfish and shellfish having an approximate value of 2.5 million dollars. Major cities within the area are Alexandria, Fairfax, Falls Church, Herndon, Leesburg, and Manassas.

Major freshwater tributaries in the region which discharge into the Potomac Mainstem are Tuscarora Creek, Goose Creek, Cameron Run, Accotink Creek, Pohick Creek, Occoquan River, Quantico Creek, Aquia Creek, Potomac Creek, Machadoc Creek, Mattox Creek, Monroe Bay, Nominy Creek, and Yeocomico River. Most of these waters have been designated as either Class IIB (estuarine primary contact) or Class IIIB (free-flowing primary contact) waters. The headwaters of North and South Fork Catoctin Creeks as well as the headwaters of Aquia Creek have been designated as Class IIIA (free-flowing secondary contact) waters. The tidal portions of Chopawamsic Creek have been designated as Class IIA (estuarine secondary contact) waters and Big Spring Creek in Loudoun County has been designated as a Class VIA (National trout) waterway.

Drinking water for the area is supplied by the Fairfax County Water Authority (FCWA), which distributes an estimated safe yield of 65 mgd to the various developments in the area. Over 90 percent of this water is supplied from water stored in the Occoquan Reservoir and approximately 7 percent is supplied from the Washington Acqueduct Division of the Corps of Engineers. Future supplies are expected to come from the Potomac River as the FCWA has applied for a permit to construct a 200 mgd intake and water treatment facility immediately above Seneca Falls and adjacent to the Fairfax and Loudoun county borders. The first phase of this project began in 1973 with an application by the FCWA to the state of Maryland for 48 mgd of water to be withdrawn by mid 1978. For the present, serious water quality problems in the Occoquan river itself have prompted the Virginia State Water Control Board to make two studies of the water quality in the reservoir. The initial study, which was initiated in 1968, defines the problems in the reservoir area, while the second study which was completed in 1970, proposed solutions and policies to solve the problems. A discussion of the recommendations and policies of the Occo-

quan Policy Statement can be found in Appendix D of the Phase I Water Quality Management Plan for Northern Virginia.(16)

Water Quality. The quality of water in the tributaries of the Northern Virginia sub-area is generally good. Degraded areas can generally be found near the urbanized areas and wastewater treatment facilities. Violations of Virginia Water Quality Standards have been reported over various time periods in the Occoquan River, South Fork Catoctin Creek, Tuscarora Creek, Goose Creek, Accotink Creek, Neabsco Creek, and Monroe Bay. High coliform densities have been the usual violator with maximum sample values exceeding the sub-class B allowable log mean of 200/100 ml sample MPN within a 30-day period. Condemned shellfish growing areas in the Virginia portion of the Potomac Estuary as of February 1, 1976, are listed in Attachment 7-B, at the back of this appendix.

Twenty-six major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the Northern Virginia sub-area and are listed along with current discharge loadings in Attachment 7-A. The loadings of each plant are presented on Plate 7-2. The Potomac-Dulles and Pimmit Run interceptors currently serve most of the metropolitan portion of the study area by conveying an average of 13 mdg to the Blue Plains Sewage Treatment Plant in Maryland. Other plants in the region are currently approaching overloaded conditions and most do not meet either the Virginia State Water Quality Standards, or the requirements of the Potomac Embayment Standards and Occoquan Watershed Policy.

Industrial discharges have not by themselves significantly degraded the quality of water within the study area. As in the Washington Metropolitan sub-area, combination of these discharges and municipal wastewater flows can and have caused some problems. Two thermal sources, the Potomac Electric Power Company (PEPCO) at Alexandria and the Virginia Electric Power Company (VEPCO) at Possum Point, have discharges of 315 and 400 mgd, respectively. Concern for the effects of these discharges on aquatic life has been great, especially at the VEPCO Plant, where many fish spawning areas are located. However, no major problems have been identified and studies are continuing to assess the overall effects of these discharges.

The main water quality problem of the Northern Virginia sub-basin has been the increased algal growth due to nutrient inputs from wastewater discharges and land runoff. The Potomac Embayment Standards developed by the State Water Control Board were designed to alleviate the problem; however, most treatment plants do not currently meet these standards due to inadequate levels of treatment. Also, rapid development in the sub-area is taking place on the assumption that additional treatment capacities will be appointed. The result is that existing treatment plants are approaching or have already exceeded design capacities.

Urban runoff and combined sewer overflow (principally from the City of

Alexandria which has a combined storm and wastewater sewerage system), have also caused stream degradation in the area. Overflows during storm periods have resulted in the direct discharge of untreated sewage into area waters.

Occasional algal blooms in the Occoquan Reservoir, which presents problems in treatment for domestic use, have been attributed to inadequate sewage treatment and heavy erosion and sedimentation within the basin. The heaviest concentration of plant nutrients are found in the Bull Run arm of the reservoir where most of the algal blooms have occurred. The problem becomes especially serious during summer months when the waters stratify and act as traps for nutrients.

Monroe Bay, which is near the Town of Colonial Beach, also experiences occasional water quality problems during the summer months. Tourist trade in the vicinity creates a five-fold increase in the population served by the Colonial Beach Sewage Treatment Plant and overloaded conditions occur. D.O. sags and high concentrations of fecal coliforms are the usual type of problems.

In conclusion, the present quality of the tributaries in the sub-basin is good. Reductions of nutrient loadings by the installation of more efficient removal processes and additional treatment plants to handle the increased flows, should help the waters meet both the Virginia State Water Quality Standards and the Potomac Embayment Standards. Possible contravention of standards may occur in streams which flow through the cities and where large quantities of untreated storm flows enter the watercourse. Control of urban and agricultural runoff will also remain a significant contributor to the degradation of the waters and the Virginia State Water Control Board is currently exploring methods for minimizing the contributions to the receiving streams.

STUDY-AREA III–RAPPAHANNOCK – YORK

The Rappahannock-York Study Area contains two sub-areas: RY-1 and RY-2. These sub-areas were formed from the two major State designated sub-basins in the area, as shown in Table 7-1. Completely within and under the jurisdiction of the Commonwealth of Virginia, this study area is shown on Plate 7-3, at the back of this appendix. Most of the information presented in this section was obtained from the Virginia Water Quality 1975 305(b) Report(13), the Rappahannock River Basin Comprehensive Water Resources Plan, 1972 (17), the York River Basin Comprehensive Water Resources Plan, 1972 (18), and the Small Coastal River Basins and Chesapeake Bay Comprehensive Water Resources Plan, 1972 (19).

SUB-AREA RY-1–(RAPPAHANNOCK)

Description. The Rappahannock River sub-basin, bound on the north by the

Potomac River Basin and on the south by the York River Basin, covers nearly 2,715 square miles of drainage in Northeastern Virginia. The river's headwaters rise on the eastern slopes of the Blue Ridge Mountains in Fauquier and Rappahannock Counties and flow 184 miles through the Piedmont and Coastal Plain Provinces to Chesapeake Bay. For the purpose of this study, the Rappahannock River Study Area begins at the confluence of the Rappahannock and Rapidan Rivers upstream of Fredericksburg and includes approximately 120 river miles to the mouth at Chesapeake Bay. Also included in the study area is the small coastal basin between the Potomac and Rappahannock Rivers containing Ingram and Fleets Bays along with their tributaries. Boundaries of this region, shown on Plate 7-3 include the Virginia State Planning Districts 16, 17, and 18. They are comprised of all or parts of the Virginia Counties of Stafford, Spotsylvania, King George, Caroline, Westmoreland, Richmond, Lancaster, Middlesex, and Gloucester.

Most of the Basin is of a rural character, with 52 percent of the land forested and 35 percent farmed or grazed. Only 45 square miles, or two percent of this area can be classified as urban. However, this figure is increasing due to the influence of the Metropolitan Washington Area. Near Fredericksburg, manufacturing is a leading source of employment and accounts for one-fourth of the total employment. In the estuarine area, employment is dependent to a high degree upon the fisheries industry. The City of Fredericksburg and Stafford County have been the focal points of urban development in the sub-basin, and the problems associated with this type of development can be expected to appear along this portion of the Rappahannock River.

Major freshwater tributaries in the region which discharge into the Rappahannock River and Chesapeake Bay include the Great Wicomico River, Corrotoman River, Lagrange Creek, Lancaster Creek, Farnham Creek, Totuskey Creek, Piscataway Creek, Hoskins Creek, Mount Landing Creek, Cat Point Creek, Occupacia Creek, Elmwood Creek, Mill Creek, Muddy Creek, Massaponax Creek, and Wilderness Run. Most of the waters in this region have been designated as either Class IIB (Estuarine Primary Contact or Class IIIB Free-Flowing Primary Contact) waters. Exceptions are the free flowing tributaries of the mainstem from Blandfield Point to the headwaters which are Class IIIA (Free-Flowing Secondary Contact) and Hoskins Creek which is a Class IIA (Estuarine Secondary Contact) waterway.

Water Quality. With the exception of the Rappahannock Mainstem near Fredericksburg and a few isolated tributaries in the immediate area, the waters of the Rappahannock Study Area exhibit a very good quality of water. Violations of Virginia Water Quality Standards have been reported in the mainstem of the Rappahannock from river mile 109 to river mile 99, Hoskins Creek, Totuskey Creek, Great Wicomico River, Indian Creek, Cockrell Creek, Dymer Creek, and Carter Creek. High fecal coliform densities and occasional dissolved oxygen sags have been the most frequent problems with fecal densities exceeding the sub-class B allow-

able log mean of 200/100 ml sample MPN within a 30-day period and dissolved oxygen minimums of less than 5.0 mg/1. Condemned shellfish areas in the sub-area as of February 1, 1976 are listed in Attachment 7-B at the back of this appendix.

Ten major municipal sewage treatment plants (average flows greater than 0.1 mgd) are within the Rappahannock sub-basin. These plants are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-3. Discharges from the municipal plants have caused few problems in the basin, with the exception of those in the Fredericksburg Area where expansion and upgrading is necessary to meet stream water quality standards.

Industries are, for the most part, small firms concerned with textiles, lumbering, metal finishing, sand and gravel mining, and seafood processing. Industrial development, though substantial, is growing at less than the average national rates. A sand and gravel company, plastic manufacturing plants, and farming operations are the major industrial sources contributing high suspended solids, heavy organic loads, and high fecal coliform concentrations, respectively.

The major water quality problems in the Rappahannock sub-basin occur in the Fredericksburg Area. Serious dissolved oxygen depletions during periods of low flow have been attributed to the heavy organic loadings imposed to the river by the City of Fredericksburg Sewage Treatment Plant and a plastic manufacturing company in the area.

In the tidal portion of the Rappahannock River, several small areas of degradation occur as a result of boating activities, raw sewage discharge, and animal waste runoff. Farming operations are also the sources of high bacteriological counts and low dissolved oxygen concentrations.

Another water quality problem area is the Windmill Point Area, near the mouth of the river at Chesapeake Bay. The major problems are high fecal coliform counts, high nutrient values, and occasional low dissolved oxygen contents. The main source of the problem at this time can be attributed to the boating activity at the Windmill Point Marina.

In the coastal area, Cockrell, Dymer, and Indian Creeks, as well as the Great Wicomico River, have experienced dissolved oxygen sags and high bacteriological counts. Most of the degradation has resulted from the direct discharge of untreated wastes from small communities in the area and the lingering effects of menhaden packing plants discharging untreated sewage to the bottom sediments from 1870 to 1945.

Relatively large amounts of fecal coliforms and sediment are added to the river by agricultural runoff. The most severe non-point source pollution

problems, however, are concentrated in the urban areas. Continued development and urbanization will increase the river's sediment problems unless strict erosion control programs are developed and enforced.

In conclusion, the present water quality of the Rappahannock River and its tributaries is good. With the expansion, construction, and improvement of waste treatment facilities as well as the implementation of non-point and marine boating regulations, the overall quality of waters can only improve. Localized degradations may occur in the near future, mainly the result of agricultural runoff and malfunctioning treatment plants.

SUB-AREA RY-2–(YORK)

Description. The York River sub-basin, which drains 2,661 square miles in East-central Virginia, is bound on the north by the Rappahannock River Basin and on the south by the James River Basin. From the headwaters of the York Basin in Orange County to the mouth, the river flows approximately 120 miles. Also included in the study area is the small coastal basin between the Rappahannock and York Rivers containing the Piankatank River and tributaries to Mobjack Bay. Boundaries of this region include Virginia State Planning Districts 15, 16, 18, and 21 which comprise all or parts of Spotsylvania, Hanover, Caroline, King and Queen, King William, New Kent, Matthews, Gloucester, James City, and York Counties as shown on Plate 7-3.

Most of the basin is wooded and rural in nature, with no major population centers located in the region. Less than two percent of the land area is classified urban. Employment is largely dependent on the manufacturing sector with primary emphasis on the lumber and food processing industries. For the most part, the sub-basin functions as a labor supply and limited residential growth area for the nearby Richmond Metropolitan Area and is not expected to develop any large scale industrial or residential areas which do not currently exist.

The York River is formed about 30 miles upstream from its mouth by two major tributaries, the Pamunkey and Mattaponi Rivers. Major tributaries of the Mattaponi River are the Matta and Poni Rivers. Major tributaries of the Pamunkey River are the North Anna, South Anna, and Little Rivers. All of the Tidal portions of the York, Pamunkey, and Mattaponi Rivers have been designated as Class IIB (Estuarine Primary Contact) waters. The free flowing freshwater tributaries of the York River have been designated as Class IIIB (Free-Flowing Primary Contact) waters while all other freshwater tributaries in the sub-area have been designated as Class IIIA (Free-Flowing Secondary Contact) waterways. Special shellfish standards also apply in this area. These standards are located in the water quality standards section of Chapter 3 of this appendix.

Water Quality. There is an obvious difference in the quality of water in different areas of the York River sub-basin. Near the headwaters in the western reaches of the basin the water is of excellent quality, while downstream of West Point and near the mouth of the York River at Chesapeake Bay, the water becomes degraded. Violations of Virginia Water Quality Standards have been reported along various sections of the mainstem of the York, Pamunkey, and Mattaponi Rivers as well as Carter Creek, King Creek, and the coastal tributaries of Put-In Creek and the Ware River. Low dissolved oxygen concentrations, low pH values, and high fecal coliform densities have been the most common problems with dissolved oxygen minimums less than 5.0 mg/l, pH values less than 6.5, and fecal coliform densities above the Sub-class B allowable log mean of 200/100 ml sample MPN within a 30-day period. Condemned shellfish areas in the sub-basin as of February 1, 1976 are listed in Attachment 7-B at the back of this appendix.

Several small sanitary discharges originating from towns, schools, and institutions discharge into the York River and its tributaries. Only 7 of these can be considered major discharges (average flow greater than 0.1 mgd) and are listed along with current discharge loadings in Attachment 7-A. The locations of these plants are presented on Plate 7-3 at the back of this appendix.

Major industrial discharges include an oil company refinery at Yorktown, a pulp and paper mill at West Point on the Pamunkey, and the Virginia Electric Power Company's (VEPCO) Yorktown Steam-Electric Plant. The largest number of pollutants entering the sub-basin are discharged from the pulp and paper mill. The addition of a waste treatment facility, however, has lowered the average BOD loading from 36,000 lbs per day to 6,300 lbs per day. Occasional spills associated with the loading and unloading of ships at the refinery docks have lessened somewhat, due to the improved protection procedures now being followed. Thermal discharges from the VEPCO Plant at Yorktown have averaged approximately 300 mgd in the past. No chronic problems have been associated with these discharges and planned expansions may increase their volumes by four times, if approved. Several smaller industrial discharges associated with sand and gravel operations also contribute to water quality degradation in the sub-basin, especially in the West Point and Yorktown Areas.

While the water quality problems of the York River are minor compared to those found in a more developed area, the following discussion outlines the known problems in order of importance within the entire basin.

Near West Point, the waters of the York Mainstem, the Pamunkey, and the Mattaponi Rivers are somewhat degraded. High coliform counts have been observed and periodically depressed dissolved oxygen conditions have also occurred. The source of the problem is suspected to be West Point Creek which receives urban runoff, landfill runoff, organic swamp drainage and the

discharge from West Point Sewage Treatment Plant. The sewage treatment plant experiences frequent operational problems but will be upgraded pending the availability of State and EPA Grant funds.

Three tributaries to the York River experiencing water quality problems are Carter Creek, King Creek, and Sarah Creek. Carter Creek has high bacteriological counts but with no apparent source of the contamination. Studies have been proposed to determine the sources of this contamination since Carter Creek is a productive shellfish area. King Creek experiences high bacteriological counts and high nutrient values. The James City County and York County Sanitary District #1 Sewage Treatment Plant is a major source of this problem. High bacteriological counts in Sarah Creek are a result of marina and boating activities in the area.

The upper reaches of the York River experience high bacteriological counts. Three of the possible sources for this contamination are (1) individual dwellings with inadequate sanitary facilities; (2) non-point source animal waste runoff; (3) high bacteriological count waters from West Point Creek, a tributary to the Mattaponi River.

Near the mouth of the York River, bottom waters often violate State Dissolved Oxygen Standards. This oxygen depletion is caused by the tidal prism effect in which stratification inhibits mixing of the bottom waters of Chesapeake Bay and the York River surface waters. This is a natural phenomena for which no solution is known at the present time.

Sedimentation is an increasing problem and the leading non-point polluter in the York River Basin. The absence of a modern soil conservation program is evident, and an estimated 40 percent of the Basin's cropland is expected to need erosion treatment. Wooded areas, comprising 68 percent of the Basin's land area, are not providing optimum watershed protection due to inadequate stocking and the inferior quality of existing timber stands. The major contributor of sediment, however, has been attributed to urban runoff although it contains only two percent of the land area. Construction activities, which expose the land for new development, have contributed to an erosion rate approaching hundreds of tons per year.

In conclusion, it is felt by the Virginia State Water Control Board that the water quality of the downstream segments of the York River Basin may not meet water quality standards in the near future but that no major cause for concern is necessary because of their relatively low priority on a statewide basis. Minor improvements, however, can be expected when industrial permit regulations are enforced and municipal sewage treatment plants are upgraded and expanded to serve currently unsewered areas.

STUDY AREA IV–LOWER JAMES

That portion of the James River drainage downstream from the confluence of the Rivanna River will be considered the Lower James Study Area, for the purposes of this report. Shown on Plate 7-3 at the back of this appendix, this section of the James Basin is completely within and under the jurisdiction of the State of Virginia. The information presented in this section was obtained from the Virginia Water Quality 1975 305(b) Report (13), the James River Comprehensive Water Resources Plan, 1972 (20), and the Lower James Comprehensive Water Quality Management Study, 1974 (21).

Description. The James River is the largest river lying entirely (except for several small tributaries) within the Commonwealth of Virginia. It flows from its headwaters in Central-western Virginia more than 450 miles to Chesapeake Bay. Of Virginia's total land area of 40,000 square miles, the James River Basin contains just over one-fourth of the State's drainage area and almost one-half of the State's population. The Lower James Basin begins at the confluence of the Rivanna and James Rivers about 40 river miles upstream of the City of Richmond and flows approximately 163 river miles to the mouth at Chesapeake Bay. Also included in this study area are the small coastal basins between the York and James Rivers and the Virginia Beach Area. Boundaries of this region include Virginia State Planning Districts 15, 19, 20, and 21. The area is comprised of all or parts of the Virginia Counties of Goochland, Hanover, Henrico, New Kent, Charles City, Powhaten, Chesterfield, Dinwiddie, Prince George, Surry, Isle of Wight, Southampton, York, and James City, as shown on Plate 7-3.

Approximately 90 percent of the land area within the Basin is agricultural, forested, or vacant land. Governmental and institutional purposes use less than half of the remaining 10 percent and the balance, or about 240,000 acres is devoted to residential, commercial, industrial and recreational uses. These uses tend to be concentrated near the major Cities of Richmond, Colonial Heights, Petersburg, Hopewell, Norfolk, Portsmouth, Hampton, Newport News, Williamsburg, and Virginia Beach. Employment in the area is centered around the manufacturing, government, and trade sectors with a diminishing dependence upon the agricultural sector. Current trends have shown a continued growth and reliance upon the manufacturing segment with a more significant increase in the service oriented industries such as education, medical-health, banking, transportation, and business-research.

Major freshwater tributaries in the region which discharge into either the mainstem of the James River or the Chesapeake Bay include the Chickahominy, Elizabeth, Appamattox, Nansemond, Poquoson, and Back Rivers as well as Falling, Big Lickinghole, Namozine, Tuckahoe, Swift, Diascund, and Pagan Creeks. Lynnhaven Bay is also a major water body in the Virginia Beach Area. Most of the waters in the region have been designated as either Class IIIA (Free-Flowing Secondary Contact), Class IIIB (Free-Flowing

Primary Contact) or Class IIB (Estuarine Primary Contact) waters. Special standards apply in the shellfish harvesting areas of the James Estuary, the impoundments and public water supply reservoirs within the study area, the Powhatan Creek Watershed, the Chickahominy River Watershed above Walker's Dam, and the Hampton Roads Sanitation District Commission Chesapeake-Elizabeth System. These standards are located in the water quality standards section of Chapter 3 of this appendix.

Water Quality. With the exception of certain notable water quality problem areas, the water quality of the entire James River is fair. The Nansemond, Appomattox, and Chickahominy Rivers within this study area are all in good condition and few water quality problems exist. Nevertheless, there are many water quality problems, some among the most severe in the Chesapeake Bay Area, along the James River Mainstem and other tributaries. Most of these occur near the Cities of Richmond, Hopewell, and in the Norfolk-Newport News Area. They are the result of the intensive residential and industrial development within the region. Non-point sources of pollution also occur with varying magnitudes throughout the Lower James Basin and have become areas of growing concern.

Violations of Virginia Water Quality Standards have been reported most frequent in segments of the James Mainstem, The Elizabeth River complex, Bailey Creek, Ashton Creek, and Lynnhaven River. Table 7-16, based upon studies performed by the Virginia State Water Control Board using the EPA (STORET) System, indicates the status of the major waters within the study area with respect to selected water quality parameters. Values presented in the table illustrate the mean of all sampling data between June and October of the years indicated. The most common problems are low dissolved oxygen concentrations, high fecal coliform densities, high nutrient values, chlorine toxicities, and heavy metal concentrations. As a result of the above problems, a substantial amount of shellfish areas have been closed. This number, in fact, represents a very high percentage of the total closed area within the Bay Region and it is for this reason that the tributaries of the James Estuary and the Mainstem have been and will continue to receive a high priority in programs designed for the enhancement of shellfish water quality. A complete listing of the closings within the Lower James River Basin as of February 1, 1976, is included in Attachment 7-B.

In the mainstem of the James River several water quality parameters have been analyzed. Dissolved oxygen has shown an improving trend in the Richmond Area due to the installation of secondary treatment in the local sewage treatment plant. However, as shown in Figure 7-11, depletion of average DO concentrations still occurs further downstream, due to the municipal/industrial complex in the Hopewell Area. The highest fecal coliform levels along the mainstem occur in the Richmond Area, but as shown in Figure 7-12, median values have decreased significantly in recent years. Again the improvement may be attributed to the upgrading of

TABLE 7-16
REFERENCE LEVEL COMPARISONS FOR
SELECTED STREAMS IN THE JAMES RIVER BASIN
(In Percentages of Observations which Exceed Reference Levels)

Stream	DO <4 mg/l 1967-71	DO <4 mg/l 1972-74	PH 6.0<PH<9.0 1967-71	PH 6.0<PH<9.0 1972-74	Fecal Coliforms >2,000/100 ml 1967-71	Fecal Coliforms >2,000/100 ml 1972-74	Orthophosphate as P >0.1 mg/l 1967-71	Orthophosphate as P >0.1 mg/l 1972-74	Kjeldahl-N >0.9 mg/l 1967-71	Kjeldahl-N >0.9 mg/l 1972-74	Nitrate-N >0.9 mg/l 1967-71	Nitrate-N >0.9 mg/l 1972-74
James River (Lower-0.5-111.6?)	7.2	1.5	1.4	0.4	22.5	6.6	7.8	7.7	31.7	5.9	16.6	4.6
Appomattox River	0.0	4.2	0.6	0.5	20.3	7.2	2.4	4.9	2.9	2.9	0.0	0.9
Chickahominy River	7.9	3.4	3.3	0.7	7.7	0.3	48.2	40.2	20.7	27.1	1.0	1.1
Elizabeth River	-	4.9	-	0.0	-	2.7	-	60.0	-	18.2	-	1.7
Southern Branch Elizabeth River	-	33.6	-	0.0	-	0.8	-	84.7	-	36.0	-	3.4
Western Branch Elizabeth River	-	0.0	-	6.5	-	1.1	-	27.0	-	15.1	-	0.0
Hampton River	-	0.0	-	1.4	-	1.1	-	4.1	-	0.0	-	0.0
Lafayette River	-	0.9	-	0.0	-	3.6	-	18.4	-	4.6	-	0.0
Ashton Creek	-	2.5	-	0.0	-	0.0	-	100.0	-	52.7	-	7.3
Bailey Creek	93.0	48.0	50.0	24.5	64.2	35.1	95.6	100.0	100.0	100.0	0.0	18.1
Bennett Creek	4.5	3.3	9.0	3.4	33.5	10.0	-	-	-	14.2	-	18.1
Falling Creek	3.6	0.0	6.5	0.0	16.0	2.1	-	16.2	13.1	5.5	0.0	0.0

- Indicated no data observed.

Source: Virginia State Water Control Board - BWCM

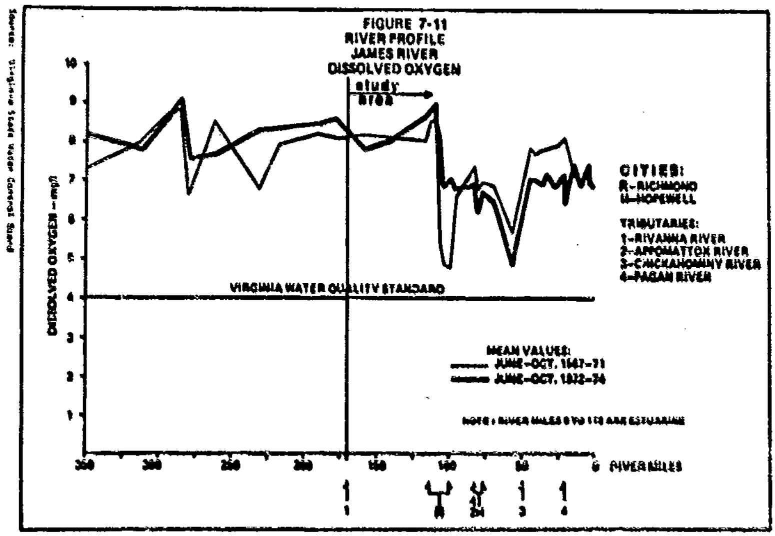


Figure 7-11: River Profile James River Dissolved Oxygen

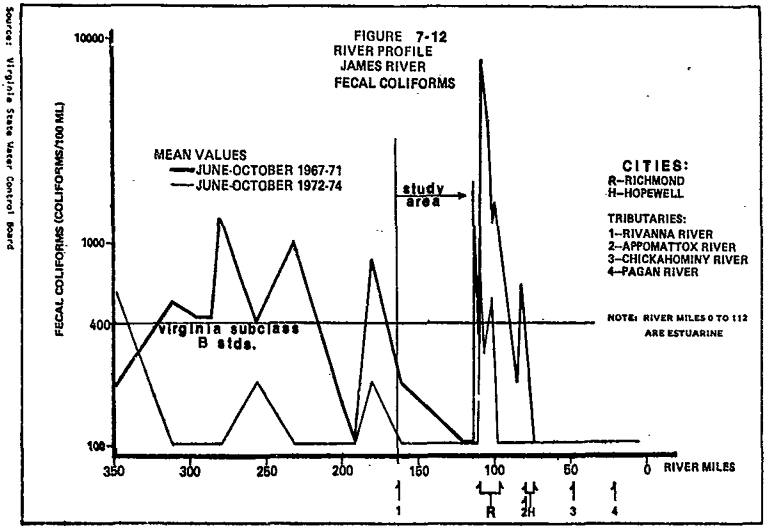


Figure 7-12: River Profile James River Fecal Coliforms

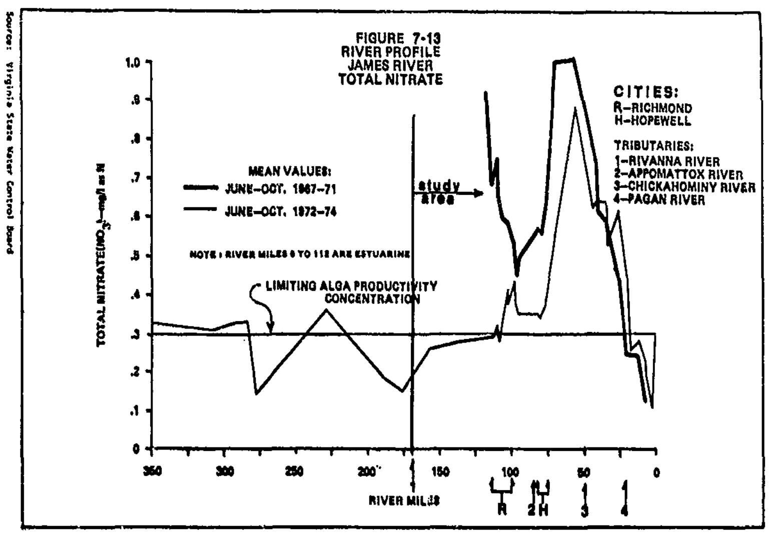


Figure 7-13: River Pro, ile James River Total Nitrate

facilities in the Richmond Sewage Treatment Plant. Mean nitrate levels (Figure 7-13) in the freshwater reaches of the James above Richmond are below or near the limiting algae productivity concentration level (0.3 mg/1). Near Richmond, a range of 0.1-0.44 mg/1 exists and below Hopewell the highest levels are encountered (0.4-0.9 mg/1). However, these levels decline to less than 0.3 mg/1 as the waters near the mouth of Chesapeake Bay. Heavy metals, sampled on only a quarterly basis, have shown concentrations of iron and manganese that frequently violate water quality standards and are considered to be critical. Pesticide concentrations have also been monitored infrequently and while no harmful concentrations were sampled during 1973, more recent developments concerning the pesticide "kepone" and other hazardous chemicals are causing great concern in the James River and southern Chesapeake Bay area. Illustrative of the magnitude of the concern is the closure, for a seven month period, of the lower James River to all fishing by Virginia governor Mills Godwin in January of 1976. Monitoring efforts are also continuing at the present time by the EPA and other Federal, State, and local agencies to determine the dispersion of this pesticide as well as its harmful effects on both man and aquatic species. Methods for cleaning up or minimizing the long term or harmful effects are also under study.

Thirty-five major municipal sewage treatment plants (average flows greater than 0.25 mgd) are located within the Lower James Study Area and are listed along with current discharge loadings in Attachment 7-A. The locations of each plant are presented on Plate 7-3 at the back of this appendix. Although several of these plants are small and cause only local degradations to the water, major problems are associated with some of the larger plants and are discussed later in this section.

Industrial development in the Lower James Area is vast and compares with the Baltimore Area as one of the Bay Area's most industrialized river basins. The more notable discharges with respect to water quality are located along the James Mainstem in the Richmond Area, Bailey Creek in the Hopewell-Petersburg Area, and along the Elizabeth River in the Norfolk-Portsmouth Area. Twenty-nine industries within the Study Area have been designated as major discharges by the Virginia State Water Control Board. Among these are five power plants (one nuclear powered) operated by the Virginia Electric and Power Company (VEPCO), several chemical manufacturing companies, and one paperboard manufacturing plant.

The Craney Island dredged material disposal site, located near the mouth of the Elizabeth River, is currently reaching its original intended capacity. Beginning in 1957, the disposal area received material from the Hampton Roads channels at a rate of 3.8 million cubic yards each year; and in 1979, the 2,500 acre site is projected to reach its total capacity of 125 million cubic yards. Additional areas or an enlarged site will then be needed. While no major water quality problems have been associated with this area to date, the threat of disposal of potentially toxic wastes in this and new

impoundments is causing concern and more environmentally acceptable alternatives are being investigated.

As previously stated, the large concentrations of population and industry in the Lower James Area have created some of the most pressing water quality problems in the Bay Area. The following paragraphs will summarize the major problems in the Lower James Area as identified by the Virginia State Water Control Board.

The James River shows water quality problems which began in the Richmond Area and end downstream from Hopewell near Weyanoke Point. The City of Richmond discharges an average of 50 mgd of municipal effluent in the same area as discharges from the Virginia Electric and Power Company (VEPCO) and several large chemical manufacturing plants. The effect of these discharges is a slight dissolved oxygen sag in the river and an increase in the concentrations of various chemical compounds, both organic and inorganic, in the river water. The overall effect is not severe and the James River usually shows fairly good water quality just downstream of the Richmond City Limits. However, during periods of heavy rainfall, considerable quantities of combined sewer overflows are discharged into the river. The result, although not thoroughly documented, is an increase in the biochemical oxygen demand and the amount of coliforms and other bacteria and viruses present in the river.

The many discharges in the Petersburg-Hopewell Area cause severe problems of low dissolved oxygen near the portion of the James River below Hopewell that is known as "Bailey's Bay." These are essentially "dead waters" and the sludge deposits in that area are expected to continue decomposing in the near future. However, improvements in wastewater treatment will greatly increase the water quality of the James River below Hopewell and enable the State Water Quality Standards to eventually be met in the "Bailey's Bay" area.

From river mile 60.5 to river mile 41.3, the James River experiences no major water quality problems. The Virginia Electric Power Company Nuclear Power Plant at Surry uses large quantities of water for cooling purposes; however, the overall effect on the river of this discharge does not appear to be causing any severe problems.

From Jamestown to the mouth, the James River Estuary currently receives in excess of 100 mdg of treated domestic waste waters. There is increasing evidence that the chlorination of these waste waters is resulting in a build-up in the river of toxic, chlorine-related compounds.

During certain times of the year, these compounds have reached levels that are harmful to certain species of fish. This has been evidenced by massive fish kills in the spring of 1973 and again in the spring of 1974 in this section of the Lower James River Estuary. Several solutions to this problem are

currently under study, including chlorination-dechlorination, disinfection by ozonation and disinfection by ultra-violet irradiation.

The James River also suffers water quality deterioration from zinc discharges from a chemical and acrylic fiber plant in the Williamsburg Area. However, improvements in waste treatment techniques should see a gradual improvement and eventual elimination of this problem.

Below the James River Bridge near Newport News, the waters experience sporadic bacteriological contamination. Severe interceptor infiltration problems at the Boat Harbor Sewage Treatment Plant pump station force the plant to occasionally discharge raw sewage to the James River where it enters Hampton Roads.

The major water quality problem area in the Hampton Roads vicinity is the Elizabeth River Complex. For many years, these waters have been receiving wastes generated by the heavy industry of the surrounding area. Suffering from many problems including low dissolved oxygen contents, high nutrient and sulfur-sulfite values, high bacteriological counts, high heavy metal values, oil spills, creosote leachate, and high temperature cooling water discharges, it is questionable whether or not this body of water can be restored so that it will provide for recreational activities in the near future. Large discharges of chelated and unchelated zinc from chemical industries combined with large quantities of heavy metals from ship refitting works, have created a situation which will generate a heavy metals problems in these waters for years to come. Recent upgrading of wastewater treatment facilities should reduce oxygen demand to the Elizabeth River but frequent changes in chemicals being produced create difficulties in maintaining a consistently effective wastewater treatment system.

Heavy traffic on the intracoastal waterway contributes to the fecal coliform and oil spill problems. Heavy yacht traffic, especially during the spring and fall contributes to peaks in the fecal coliform values. Enforcement of VSWCB Boating Regulations in 1976 should help to eliminate these problems.

The Pagan River water quality problems are caused by discharges from meat packing plants, poorly treated municipal wastewaters, and the oxygen demands of benthic organisms. Some improvement in water quality should be observed with a tenfold reduction in BOD loading and addition of disinfection at a meat packing company plus upgrading of the Smithfield Sewage Treatment Plant.

The Nansemond River presently experiences water quality problems of high fecal coliforms and low dissolved oxygen levels that stem from the City of Suffolk municipal discharges. Boating activities on the river have also resulted in fecal coliforms being discharged to the Nansemond River. These problems should be eliminated by more vigorous enforcement of Virginia State Water Control Board Boating Regulations.

Lastly, a major water quality problem (involving sedimentation and high bacteriological counts) occurs in the Lynnhaven River. Main sources of high bacteriological counts are the heavy boating and marina activities, discharge of many small sewage treatment plants, and leachate from inadequate septic tank systems. The sediment problem results from tidal scour within marsh guts for which there is no planned control method, and from urban runoff, especially sedimentation resulting from subdivision construction.

In summary, the waters of the Lower James River Basin suffer from the extensive municipal and industrial complexes concentrated in this area. Nonetheless, from inspection of the water quality data presented earlier, it can be seen that a general improvement over recent years has resulted from implementation of improved wastewater treatment techniques and management policies required by the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). Additional improvements can be expected in the near future as enforcement of more strict boating regulations, upgrading of other sewage treatment facilities and implementation of Water Quality Management Plans continue. However, heavy metal concentrations in bottom sediments, toxic chemical discharges, urban and tidal runoff, and high residual chlorine levels will remain significant problems in the near future and the Lower James River Basin will probably continue as one of the basins of most concern in the Chesapeake Bay region.

STUDY AREA V–LOWER EASTERN SHORE

The Lower Eastern Shore Study Area is composed of three sub-areas: LE-1, LE-2, and LE-3. These sub-areas were formed from the major river basins in the area as shown in Table 7-1. Pictured on Plate 7-2, at the back of this appendix, are the boundaries of this study area which encompasses the States of Virginia, Maryland, and Delaware. Following is a description of existing water quality conditions for each sub-area as summarized from the Accomack-Northampton Planning District 303(e) Water Quality Management Plan (22), and the Maryland (5), Virginia (13), and Delaware (23) 1975 Water Quality 305(b) Reports.

SUB-AREA LE-1–(ACCOMACK-NORTHAMPTON)

Description. Located on the peninsula between the Atlantic Ocean and Chesapeake Bay on Virginia's Eastern Shore, the counties of Accomack and Northampton, or Virginia's Planning District 22, comprise sub-area LE-1. Boundaries of the portions of these counties which drain to Chesapeake Bay are shown on Plate 7-2. The area is characterized by very sparsely populated areas with approximately 30 percent of the total land area in cropland, about 34 percent forested, and only 2 percent urbanized. The area's chief source of income stems from the extensive agricultural development for which the area has long been noted. Extensive oyster and clam beds also provide a rich natural resource which supplies employment for many residents. The beaches, saltwater sports, and historical landmarks attract

many tourists as does the new Chesapeake Bay Bridge-Tunnel connecting the southern tip of Northampton County with Virginia Beach and the Virginia mainland.

The major tributaries in this region are small, both in length and size, and are usually bound by marshes. Those draining to Chesapeake Bay are Pungateague, Occohannock, and Nassawadox Creeks, all classified by Virginia State Water Quality Standards as Class II B (Estuarine Primary Contact) waters. Several smaller tributaries within the tidal reach of Chesapeake Bay are also classified Class II B. All other tributaries in the study area are considered free-flowing and therefore have been classified Class III B (Free-Flowing Primary Contact).

Water Quality. In general, the water quality of Virginia's Eastern Shore can be classified as good, although several problems, minor in comparison to the remainder of the Bay, do exist. Violations of Virginia Water Quality Standards occur mainly in Pitts, Messongo, Warehouse, Parting, and Nassawadox Creeks, as well as in the Cape Charles Harbor Area. The most frequent parameters violated are low dissolved oxygen contents and high nutrient and bacteriological values. These violations result from inadequately treated or improperly released septic tank leakage, and inadequately treated or improperly released discharges from vegetable and poultry packing industries in the area. Several shellfish areas have been closed in this area as of December 31, 1974 and are listed in Attachment 7-B, at the back of this appendix.

Only three major municipal sewage treatment plants (average flows greater than 0.1 MGD) are within sub-area LE-1 and are shown on Plate 7-2. Current discharge loadings are also presented in Attachment 7-A, at the back of this appendix. The Town of Cape Charles presently has no treatment and discharges approximately 2.0 mgd of raw sewage into Cape Charles Harbor. Industrial discharges are also few and only a poultry and two vegetable packing companies are considered major, causing some water quality problems in the region.

The towns of Hallwood and Exmore have problems with failing septic tank systems. The Town of Onancock STP requires upgrading from primary to tertiary treatment. The Town of Cape Charles which presently discharges raw sewage from a central collector system into Cape Charles Harbor, requires construction of a sewage treatment plant.

Poultry and vegetable packing plants are being issued NPDES Permits which in some cases require not only treatment or upgrading of treatment, but also discharge in proportion to stream flow. It is expected that these methods will improve the water quality of affected streams.

An additional source of nutrient and dissolved oxygen problems in the study area is agricultural runoff. Studies are necessary to determine what agricultural management practices are necessary to minimize the effects of this source.

The principal water quality problem in the vicinity of Tangier Island is high bacteriological counts which not only violate water quality standards but also provide a threat to the health of the citizens. The primary source is leachate from individual septic tank drainfields. Also, contamination of State waters via surface runoff is of major concern due to the island's large domestic animal population, utilization of surface privies, and the present mode of solid waste disposal. In order of achieve water quality standards, a central sewage collection and sewage treatment facility is necessary.

As implementation of Water Quality Management Programs proceed, stressed conditions can be expected to improve. The future trend should be toward higher dissolved oxygen contents and lower bacteriological values as septic tank leachates are corrected and sewer extensions are made available. Agricultural runoff, however, will remain a significant factor until greater headway is made with land treatment practices.

SUB-AREA LE-2–(POCOMOKE)

The Pocomoke River, designated as a scenic river by the State of Maryland, originates near the Maryland-Delaware State Line in the "Great Cypress Swamp" of Delaware. Flowing 55 miles to Pocomoke Sound on the Bay, the river passes through very sparsely populated low-lying areas in the Southeastern Maryland Counties of Somerset, Wicomico, and Worcester. Boundaries of sub-area LE-2 are shown on Plate 7-2, at the back of this appendix. The largest population centers in the Basin are Pocomoke City (pop. 3,600) and Snow Hill (pop. 2,200). The tidal influence of Chesapeake Bay extends approximately 23 miles upstream or just above Snow Hill.

Freshwater tributaries within the region are Dividing and Nassawango Creeks, as well as Little and Big Annemessex and Manokin Rivers. Eleven percent of the 888 square mile drainage area consists of wetlands, which are very important to fish and wildlife habitats and the entire Chesapeake Bay ecosystem. This area also marks the northern limit of many forms of plant and aquatic life.

All estuarine portions of tributaries in the Pocomoke River sub-basin have been designated by the State of Maryland as Class II for shellfish harvesting, except for the Manokin River and all tributaries above Route #363, the Big Annemessex River and tributaries above River Road, Jenkins Creek above the mouth and Fair Island Canal. These and all other waters of this sub-basin are designated Class I for water contact recreation and aquatic life uses.

TABLE 7-17
WATER QUALITY IN THE POCOMOKE RIVER BASIN

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	TEMP.	PH	BACTERIA	
Pocompke Sound	yes	yes	yes	*	Eastern quarter of Sound closed to shellfish harvesting because of stormwater runoff of marshlands, agricultural and animal origin.
Pocomoke River-Mainstem	yes	yes	yes	*	Bacterial levels in excess of numerical standards recorded at river miles 14.6, 17.0, and 43.2. Enrichment noted in lower half of river from point and non-point source. waste.
Dividing Creek	*	yes	yes	*	D.O. less than and bacteria in excess of numerical standard recorded at river mile 14 from non-point source.
Nassawango Creek	yes	yes	yes	*	Bacteria in excess of numerical standards and enrichment noted in upper creek. Land runoff suspected.
Pocomoke City Snow Hill Area	*	yes	yes	*	D.O. less than and bacteria in excess of numerical standard recorded. Sluggish character of streams and land runoff degrade water quality periodically.
Tangier Sound	yes	yes	yes	yes	Excellent quality--entire area open to shellfish harvesting
Little Annemessex River	yes	yes	yes	*	Shellfish harvesting closed above line from Great Point to Long Point as buffer zone for Crisfield STP and individual septic tank failures in area.
Big Annemessex River	yes	yes	yes	*	Bacteria levels in excess of numerical standards recorded and some enrichment indicated from point and non-point sources.
Manokin River	*	yes	yes	*	D.O. less than and bacteria in excess of numerical standard recorded in upper river from point and non-point sources Shellfish harvesting areas open.
Pocomoke River East	-	-	-	-	No data.
Pocomoke River West	*	yes	yes	*	D.O. less than and bacteria in excess of numerical standards recorded. Some may be natural while others result from land runoff.
Corbin Area	-	-	-	-	No data.
Pocomoke River--other--lower west	-	-	-	-	No data.
Deal Island	yes	yes	yes	yes	Good quality--some enrichment noted from point and non-point sources.
North Pocomoke Sound	yes	yes	yes	*	Bacteria levels in excess of numerical standards recorded in Johnson and Marumsco Creek from point source and non-point source waste.

Source: (5)

Water Quality. A summary of the status for tributaries in this sub-area, with respect to various water quality parameters and standards developed by the State of Maryland is shown in Table 7-17.

The overall quality of the Pocomoke River is good except for some minor and localized water quality problems near Pocomoke City, Snow Hill, Princess Anne, and Crisfield. These problems consist mainly of overenrichment, oxygen depletion, and bacterial contamination. Closed shellfish areas in the sub-basin as of 31 March 1976 are listed in Attachment 7-B.

Municipal and industrial discharges in the Pocomoke River Basin are few and discharge relatively small volumes of wastewater daily. Only four major municipal sewage treatment plants (average flows greater than 0.1 MGD) are within the study area and are shown on Plate 7-2 at the back of this Appendix. Current discharge loadings are also included in Attachment 7-A. Industrial discharges including meat packing plants, petroleum distributors, and a few canning companies discharge into the waters of the Pocomoke causing only localized areas of degradation.

Of the fifteen State designated segments within this sub-basin, water quality standards are not met for pH by seven segments, for dissolved oxygen by five segments, and for bacteria by nine segments. Low pH values are evidently the result of the swamp characteristics of this sub-basin and not the result of wastewater discharges. Low dissolved oxygen (D.O.) values result from the sluggish, swampy, natural conditions, while in the more developed areas they appear to result from agricultural or land runoff as well as from point sources (Pocomoke City-Snow Hill Areas). A sluggish tidal system in conjunction with the swamp type environment combine to produce naturally low pH values and occasional dissolved oxygen sags.

Additional sources of non-point pollution in the sub-basin result from septic tank leachate. Areas with failing septic tanks have been observed near Pittsville, Williams, Snow Hill, Pocomoke City, Deal Island, Oriole, Fairmount, Manokin, Westover, Marion, and Crisfield.

Water quality trends in the main river show improvement in most parameters, particularly with respect to D.O. levels. Sampling results from 1974 showed no violations of this standard during daylight sampling periods as opposed to recorded violations during the same time periods in earlier years. The sanitary quality on the Pocomoke Mainstem has improved since 1971, although violations of bacterial standards were still noted in 1974. Two areas with violations are adjacent to the population centers of Snow Hill and Pocomoke Ctiy.

These improvements can be attributed to improved treatment facilities and reduced loadings of oxygen demanding materials. Continued improvement in wastewater treatment in the Pocomoke sub-basin, guided by the results of ongoing wastewater management studies, should continue to bring improvement to water quality in this sub-basin.

SUB-AREA LE-3–(NANTICOKE)

Description. The Nanticoke River sub-area lies near the middle of the Delmarva Peninsula on Chesapeake Bay. Originating in the State of Delaware, the Nanticoke and all its tributaries (including Marshyhope, Transquaking, and Wicomico Creeks, and Wicomico, Chicacomico, and Blackwater Rivers) cover a drainage area of about 1,054 square miles. Boundaries of this area, including the Maryland Counties of Caroline, Dorchester, Somerset, and Wicomico, as well as the Delaware Counties of Kent and Sussex are shown on Plate 7-2 at the back of this Appendix.

The area is characterized by heavily ruralized areas, with about 90 percent of the land area undeveloped. However, population centers and associated wastewater sources are in the basin and are located at Seaford and Laurel in Delaware and at Sharptown, Hurlock, Vienna, Federalsburg, and Salisbury in Maryland. The largest urban-industrial center on Maryland's Eastern Shore is

TABLE 7-18
WATER QUALITY IN THE NANTICOKE RIVER AREA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Nanticoke--Mainstem	yes	yes	yes	*	*River from mile 6.3 to 14.3 closed to shellfish harvesting from runoff sources including agriculture, animals, deficient septic tanks and inadequate sewage treatment at some public facilities.
Marshy Hope Creek	yes	yes	yes	*	*Numerical standards for fecal coliform bacteria are exceeded in Wrights Branch and in Marshy Hope Creek above and below Federalsburg. Waters are enriched from WWTP's and runoff.
Nanticoke--West	yes	yes	yes	yes	Good quality
Fishing Bay	yes	yes	yes	yes	Excellent quality.
Transquaking	*	yes	yes	*	*DO's less than and bacteria in excess of numerical standards were recorded at river mile 23.6 from point and nonpoint sources. System is generally enriched.
Chicamacomico	yes	yes	yes	yes	Good quality.
Blackwater	yes	yes	yes	yes	Good quality.
Nanticoke--East	yes	yes	yes	*	*Numerical standard for fecal coliform bacteria exceeded in Wetipquin Creek.
Nanticoke--North	-	-	-	-	No data. Good quality assumed by association with good, adjacent receiving water quality.
Wicomico-Main Stem	yes	yes	yes	*	Enriched system from point source and non-point source wastewater. *Closed for shellfish harvesting from river mile 2.3 to 5.0.
Wicomico Creek	yes	yes	yes	*	Enriched from river exchange. Numerical bacterial standard exceeded in lower reaches from land runoff or marina source.
Ferry Point	-	-	-	-	No data.
Monie Bay	yes	yes	yes	*	*Numerical bacterial standard exceeded near mouth of Monie Creek. Monie Bay open to shellfish harvesting.
Wicomico--West	-	-	-	-	No Data.
Wicomico--Head	*	yes	yes	*	Point and non-point sources create many enriched areas, particularly in impoundments. *Numerical standards for DO's and bacteria were not met in Sharps Creek, which drains the Fruitland area.

Source: (5)

also in this study area and begins near Salisbury or approximately 18 miles above the mouth of the Wicomico River. Wetlands constitute about 20 percent of the sub-basin's undeveloped area. In addition, one of the most important striped bass spawning and production areas in Maryland is found from river mile 6 to 26 in the Nanticoke Mainstem.

All estuarine portions of tributaries in the Nanticoke River sub-basin are designated Class II for shellfish harvesting except for Blackwater River and all tributaries above the mouth, Transquaking River and all tributaries above the mouth, the Nanticoke River and tributaries above a line from Runaway Pt. to Long Pt. (approximately river mile 10), the Wicomico River and all tributaries above the ferry crossing at White Haven, and Monie Creek above the mouth. These and all other waters of the sub-basin are designated Class I for water contact recreation and aquatic and wildlife uses.

Water Quality. Table 7-18 indicates the status of the tributaries in this segment with respect to various water quality parameters and standards developed by the State of Maryland.

Existing water quality data for the drainage of the Nanticoke River reveals generally good quality water. No violations of the Delaware Water Quality Standards for mean dissolved oxygen contents or geometric means of fecal coliforms have been reported in the Delaware segments from May to October 1974. The most commonly violated standard in the Maryland portion is for bacteria. Sections of the Nanticoke Mainstem, Transquaking Creek, and the Nanticoke East all experience high bacteria with the sources remaining unknown. Enrichment, based on chlorophyll *a* levels, is most notable in Marshyhope Creek which receives treated wastewater, the Transquaking River, which also receives treated wastewater, the Blackwater River which is principally marsh, and the Nanticoke East segment which is basically agricultural. Shellfish closures, in both the Nanticoke and Wicomico Rivers are due basically to storm water runoff, sewage violations from individual homes, and public sewage facilities discharging inadequately treated sewage. These areas updated to 31 March 1976, are listed in Attachment 7-B at the back of this appendix.

Sampling during 1974 by the State of Maryland indicates that, based upon chlorophylyll *a* levels, the Wicomico River is an enriched system from both point and non-point pollution sources. Values for chlorophyll frequently exceed values expected to be sufficient to cause algal blooms in the lower 14 miles of the river. Occasionally, high bloom levels are also noted upstream of mile 14 to Salisbury. Bacteria standards are exceeded in four of six segments of the watershed including Wicomico Creek, Monie Bay, and the headwaters of the Wicomico Mainstem. Sources of this contamination have not yet been determined. Dissolved oxygen values, though adequate to meet applicable standards, do experience obvious sags below wastewater treatment plants.

There are nine plants (average flows greater than 0.1 mgd) and 33 industrial wastewater sources in the Nanticoke sub-basin. The municipal sewage treatment plants are listed along with current discharge loadings in Attachment 7-A. at the back of this Appendix. The locations of each plant are also shown on Plate 7-2. The major industrial discharger is a nylon manufacturing plant at Seaford contributing cooling discharges and an estimated loading of 400 lbs/day of BOD. Other industries, including several poultry and seafood packaging companies discharge into the waters of the basin. Several of the industries are connected to the municipal sewage treatment plants in the area while few use land disposal techniques.

Agricultural runoff constitutes the major source of non-point waste in the Nanticoke sub-basin. Drainage from these lands contributes bacterial and nutrient sources from soils, applied fertilizer, manure seepage, and feedlot runoff. Other non-point sources include localized septic tank failures and urban land runoff from the more populated areas in the sub-basin.

Studies indicate varying degrees of eutrophication in the Salisbury Ponds. In some cases, nutrient enrichment can be traced to a particular point source, whereas in the majority of cases, the nutrient appears to come from non-point sources.

Improvements in wastewater treatment plant efficiences, sediment control, stormwater runoff, and the application of agricultural runoff practices, should improve the quality of the water in the Nanticoke River sub-area, especially with respect to dissolved oxygen and bacteria levels. In the Wicomico River general reductions of bacteria and eutrophication levels can be expected. However, upstream sources of nutrients, as yet undetermined, will continue to cause occasional problems.

STUDY AREA VI–UPPER EASTERN SHORE

The Upper Eastern Shore Study Area is composed of three sub-areas: UE-1, UE-2, and UE-3. These sub-areas were formed from the designated basins, as shown in Table 7-1. Boundaries of this region, including a portion of the Upper Eastern Shore of the State of Maryland and a small portion of the State of Delaware are shown on Plate 7-1, at the back of this appendix. Most of the information presented in this section was obtained from the Maryland Water Quality 75 305(b) Report(5) and the Elk(24) 303(e) Water Quality Management Plan.

SUB-AREA UE-1–(CHOPTANK)

Description. The Choptank River is the largest river on the Eastern Shore draining a small portion of Kent County in Delaware, and Talbot, Caroline, and Dorchester Counties in Maryland. The larger water bodies which are tributary to the sub-basin include the Choptank River Mainstem Honga River, Little Choptank River, Harris Creek, Broad Creek, Tred Avon River, and Tuckahoe Creek. The tidal portion of the mainstem extends past the Town of Denton to a point just downstream from Greensboro. Boundaries of this sub-basin are shown on Plate 7-1.

The area is characterized by intense agricultural development with small population centers scattered throughout. Major towns are Easton (pop. 6,800) and Cambridge (pop. 11,600) with the smaller communities of Queen Anne-Hillsboro, Ridgely, Denton, Greensboro, Preston, and Secretary-New Market located along or near the Route 50 corridor. The total area, including both land and water surface areas, is approximately 867 square miles.

All estuarine portions of tributaries in the Choptank River Area sub-basin are designated Class II–for shellfish harvesting, except for the Choptank River and tributaries above a line from Bow Knee Point to Wright Wharf, and the Tred Avon River and tributaries above Easton Point. These and all other waters of this sub-basin are designated Class I for water contact recreation and aquatic and wildlife uses. Of the Class II shellfish harvesting areas, 2,647 acres of natural oyster bars have been closed, along with 380 acres of State oyster plantings, 141.5 acres of leased oyster ground and 65 acres of chartered clam bar. The Upper Choptank is a prime spawning area for the striped bass (Rockfish).

TABLE 7-19
WATER QUALITY IN THE CHOPTANK RIVER AREA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Honga River	Yes	Yes	Yes	Yes	Natural marsh area - shellfish harvesting - all open except Back Creek.
Little Choptank River	Yes	Yes	Yes	*	*Shellfish area open for lower area - upper half closed. Shoreline violations.
Choptank River, mainstem	Yes	Yes	Yes	*	Heavy algae blooms in upper tidal area. Shellfish open below Hambrooks Bar. *Exceeded numerical limit in upper shellfish area (Class II) and upper Class I.
Harris Creek-Blackwalnut Cove	Yes	Yes	Yes	*	*Shellfish area closed around Tilghman Island - shoreline violations-Harris Creek shellfish area open.
Broad Creek.	Yes	Yes	Yes	*	*Small shellfish area closed in upper San Domingo Creek - shoreline violations and runoff.
Tred Avon River	Yes	Yes	Yes	*	*Upper 1/3 of river closed to shellfish and tributaries - shoreline violation and Easton buffer zone.
Hunting Creek	Yes	Yes	Yes	*	Agricultural area and STP effluent. *Exceeded numerical limit.
Tuckahoe Creek	Yes	Yes	Yes	No	Sanitary, industrial and agricultural waste problems - algae bloom - lower tidal area.
Trippe Bay	-	-	-	-	Bay side area - no problems.
Choptank River Area Bay	-	-	-	-	Small shellfish area closed near Tilghman Island - shoreline violations.
Cambridge	Yes	Yes	Yes	*	Algae blooms in tidal creeks heavy. Local STP's and shore line violations - *Tidal creeks area closed to shellfish above Horn Pt.
Choptank River Northwest	*	Yes	Yes	*	Industrial, sanitary and agricultural waste problems - *Bacteria exceeded numerical limit. Low D.O. in Miles Creek and Easton Lagoon Trib. Tidal creek areas closed to shellfish.
Choptank River East	-	-	-	-	Some local agricultural waste problems.
Choptank River Headwaters	Yes	Yes	Yes	*	Sanitary and agricultural waste. *Exceeded numerical limit in some tributaries. High nutrients and algae levels.

Source: (5)

Water Quality. A summary of the status for tributaries in this sub-basin with respect to various water quality parameters and standards developed by the State of Maryland is shown in Table 7-19.

Water quality in this watershed, including the Choptank Mainstem and Little Choptank River is generally good. However, monitoring by the Maryland Water Resources Administration in 1974 has shown that certain areas exhibit low dissolved oxygen and/or high bacterial values, mostly the result of inadequately treated domestic and industrial wastes in the populated areas and agricultural and urban runoff in other cases. Increasing chlorophyll *a* values in some areas indicate a trend toward more eutrophic conditions and nutrient removal at treatment plants and more stringent land control measures have been deemed necessary to correct the situation. Several shellfish bed closures as of 31 March 1976 have been necessitated by deteriorating water quality conditions and are listed in Attachment 7-B at the back of this Appendix.

Nine major municipal sewage treatment plants (average flows greater than 0.1 MGD) and several small industries are within the boundaries of sub-area UE-1. A list of the municipal facilities, along with current discharge loadings, is presented in Attachment 7-A at the back of this Appendix. The locations of each plant are presented on Plate 7-1. These plants are significant contributors to the increasing chlorophyll *a* values, high fecal coliform concentrations, and low dissolved oxygen contents found in some of the receiving waters of the region. Overloaded conditions and inadequate treatment along with steadily increasing flow rates have been identified as the basic problem, requiring larger buffer zones and increased shellfish closure areas. Industrial discharges, basically involved with seafood canneries and food processing plants, are also contributors to low dissolved oxygen contents and high fecal coliform densities in the area, expecially in the Miles and Tuckahoe Creek Areas.

Non-point sources of pollution in the basin are significant and consist mainly of agricultural runoff and septic tank leachate. The agricultural waste problem is spread throughout the basin, but most problems cited in the past have been found in the heavily farmed areas above Cambridge. Specific areas are in Miles Creek, Fowling Creek, the mainstem above the Town of Choptank, Broadway Branch and other unnamed tributaries. The nature of the problem centers in the headwaters of the small tributaries away from the main loads, which prevents their being found easily. Septic system problems in the unsewered communities stem mainly from their location in unsuitable soils and occasional overflows. Main problem areas in the sub-basin are at Fishing Creek, Hooper Island; Church Creek, Madison; Tilghman Island, near Easton; St. Michaels, Cambridge; Hillsboro, Queen Anne; and most of the small unsewered communities above Denton. Plans are being formulated to extend sewers or build treatment plants in these areas, however, many are only included in long term plans (1990).

In the Choptank River from the headwaters to the mouth of Tuckahoe Creek, inadequately treated and untreated sewage wastes, industrial wastes, and runoff from agricultural areas are the main problems. Tuckahoe Creek receives wastewater from cannery industries and faulty septic systems and is degraded in the Hillsboro-Queen Anne Area.

In the Easton Area, an unnamed tributary receives the sanitary waste effluent from the local sewage treatment plant and exhibits low dissolved oxygen and high bacteria and chlorophyll *a* values. The Miles Creek Drainage, near the Town of Trappe, is in serious violation of the bacteria and dissolved oxygen standards for Class I waters. Fecal coliform bacteria ranged from 230 MPN/100 ml to 2,400,000 MPN/100 ml and dissolved oxygen went as low as 2.2 mg/1. The main sources of pollution are from a cannery, food processing plant, and a large dairy farm.

In the Cambridge Area, wastes from the city sewage treatment plant and bypass outfalls cause bacteria contamination in the shoreline waters. These wastes, combined with pollutants from upstream, are responsible for the closure of shellfish areas. Substantial progress has been made in the construction of a secondary treatment facility and separation of storm and sanitary sewers by the City of Cambridge.

The Tred Avon River, tributary to the Choptank River near its mouth, does not meet the bacteria standard for shellfish harvesting in its headwaters. These waters drain the Easton Area and are degraded by wastes from septic systems and land runoff.

The Little Choptank River is generally free of pollution. However, bacteria standards are not met in certain sections of the river and its tributaries due to faulty septic systems and agricultural runoff. The upper half of the tidal area is closed to shellfish harvesting.

In the near future, the Choptank River sub-area should experience some improved water quality due to the upgrading of area sewage treatment plants to secondary treatment. However, increasing municipal flows will contribute greater nutrient loads and possibly greater algal bloom problems unless advanced treatment is utilized to remove nutrients. Agricultural runoff and faulty septic systems will also require closer study, enforcement, and inspection before any major improvement can be expected in the waters of the entire sub-basin.

SUB-AREA UE-2–(CHESTER)

Description . The Chester River sub-basin shown on Plate 7-1, is contained within Maryland's Eastern Shore Counties, of Kent, Queen Annes, and Talbot. The mainstem of the Chester River, which is 42 miles long and tidal throughout, forms the boundary between Kent and Queen Annes Counties as it flows from its headwaters near Delaware to the Bay. Kent Island separates the Lower Chester River from Eastern Bay, which lies to the south. Major tributaries along the Chester Mainstem are Corsica River and Langford Creek while Miles and Wye Rivers discharge into Eastern Bay. Approximately 600 square miles of land area drain into this sub-basin, two-thirds of which is that of the Chester River proper.

This sub-area, as was sub-area UE-1, is a heavy agricultural area and, coupled with the fisheries in the area, provides the primary support of economy for the Region. Few population centers are found in the area, the largest being Chestertown (pop. 3,476) and Centreville (pop. 1,853).

All estuarine portions of tributaries in the Chester River Area sub-basin are designated Class II for shellfish harvesting, except for Chester Creek and tributaries above Route #213, Corsica River above Earl Cove, Piney Creek

above Route #50, Winchester Creek above the mouth, and St. Michaels Harbor. These and all other waters of this sub-basin are designated Class I for water contact recreation and aquatic and wildlife uses.

Water Quality. Table 7-20 indicates the status of the tributaries in this segment with respect to various water quality parameters and standards developed by the State of Maryland.

In general, the water quality of the watershed is good. However, nutrient concentrations in the Chester River have shown significant increases from 1965 to 1974. In 1965, concentrations were generally low and algal blooms were small. In 1974, total phosphate phosphorus and inorganic nitrogen concentrations were great enough to support moderatly large algal blooms in the upper river from Chestertown to Crumpton.

The sanitary quality of the mainstem has also gradually worsened over the past several years. Various areas in the Chester River sub-basin have been closed to shellfish harvesting because the water does not meet the Class II bacteria standard for shellfish harvesting. Within the past three years, the shellfish closure line was moved from Quaker Neck Landing to its present location between Cliffs Point and a point northeast of Spaniard Point, a distance of approximately five miles. A list of all the shellfish closures as of December 31, 1974 is presented in Attachment 7-B at the back of this Appendix. Also included is an update of closings effective March 31, 1976.

Only four major municipal sewage treatment plants (average flows greater than 0.1 mgd) and a few small industries are within the boundaries of sub-area UE-2. A list of the municipal facilities along with current discharge loadings, is presented in Attachment 7-A at the back of this appendix. The locations of each plant are also presented on Plate 7-1. The largest municipal plant in the basin is the Chestertown Plant (0.9 mgd), which has its outfall on Radcliff Creek approximately one mile above the Chester River. Other municipal discharges are small in comparison to those found in other Bay Study Areas and cause only localized degradations in the form of high BOD and low DO. Industrial discharges and the related problems are few in the sub-basin. However, the concentration of seafood packing industries in the Kent Narrows Area has caused some problems and contribute to water quality degradation.

Non-point sources of pollution such as farm animal wastes, septic tank seepage, urban runoff, and domestic wastes from boating activities contribute significantly to water quality degradation in several areas of the sub-basin. Agricultural runoff problems, basically the result of wastes from large farms, are found most often near the headwaters of the Chester Mainstem, Southeast Creek, and the Corsica and Wye River Areas. Boating activities in the Queenstown, Kent Island, and the Wye and Miles Rivers, especially the St. Michaels Harbor, are believed to be causing problems with respect to high BOD and DO sags. Septic system problems in the unsewered

TABLE 7-20
WATER QUALITY IN THE CHESTER RIVER AREA

SEGMENT	MEETS WATER QUALITY STANDARDS D.O.	Temp.	pH	Bacteria	COMMENTS
Chester River Mainstem	yes	yes	yes	*	Water quality of the lower Chester River is generally good. *Fecal coliform values did not meet shellfish standards from the Route 213 bridge at Chestertown, the upper boundary for shellfish waters, to a line between Cliffs Point and a point near Spaniards Point. The upper river at Crumpton did not meet the Class I standards for bacteria. Causes of high bacterial values were sewage treatment plant discharges, the Campbell Soup Co. discharge, septic tank seepage and urban runoff. Phosphorus compounds were high in Morgan Creek and Radcliff Creek, but low in other tributaries.
Chester River Headwater	yes	yes	yes	*	*Bacterial values did not meet the standards in Morgan Creek and Radcliff Creek. In Red Lion Branch below Sudlersville biological indices suggested water quality degradation. Probable causes of degradation in this segment were Chestertown STP, the Campbell Soup Co discharge, agricultural runoff, septic tank seepage and urban runoff. Phosphorus compounds were high in Morgan Creek and Radcliff Creek, but low in other tributaries.
Southeast Creek	yes	yes	yes	no	Bacterial values did not meet shellfish standards in creek. Causes of poor water quality were septic tank seepage and urban runoff from Church Hill.
Oldtown	-	-	-	no	Waters did not meet shellfish standards.
Indiantown Riverview	-	-	-	no	Water did not meet shellfish standards.
Langford Creek	-	-	-	no	Most of creek did not meet shellfish standards.
Corsica River	no	yes	yes	no	The entire river did not meet shellfish standards. A tributary, Gravel Run, was polluted by oil wastes and urban runoff from Centreville, and by unknown sources of pollution upstream. Ph in Gravel Run was outside the lower limit set by the standard. The Centreville STP contributes high nutrient concentrations to this stream.
Eastern Neck	yes	yes	yes	no	Grays Inn Creek did not meet shellfish standards. Causes of poor water quality are septic tank seepage and agricultural runoff.
Queenstown	yes	yes	yes	no	Queenstown Creek did not meet shellfish standards. The Queenstown STP effluent has caused organic pollution in Little Queenstown Creek.
Kent Island Narrows	yes	yes	yes	no	Bacterial pollution by seafood industry effluents and septic tank seepage have resulted in partial closure of the Narrows to shellfishing.
Rock Hall	-	-	-	no	Bacterial pollution by urban runoff, septic tank seepage and boat wastes have resulted in partial closure of Rock Hall harbor and Swan Creek to shellfishing.
Cloverfields	-	-	-	-	There are no known problems in this segment.

TABLE 7-20 (Cont'd)
WATER QUALITY IN THE CHESTER RIVER AREA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Kent Island Bay	yes	yes	yes	*	*Prices Creek did not meet bacteriological standards. DO values below the DO standard in bottom samples were recorded in the vicinity of Kentmoor Marina and Pier I Marina. There are no known problems in the other creeks and embayments.
Eastern Bay	yes	yes	yes	yes	Water quality good.
Eastern Bay North	yes	yes	yes	*	Water quality degraded by seafood industry discharges in the Kent Narrows area and sewage treatment plant wastes.
Eastern Bay South	-	-	-	-	There are no known problems in this segment.
Wye River	yes	yes	yes	no	The majority of Wye East River and Wye River, and Wye Narrows did not meet the shellfish standards. Water quality degraded by agricultural wastes and septic tank seepage.
Miles River	yes	yes	yes	*	Water quality of the lower Miles River is generally good. *The Miles River is closed to shellfishing upstream from a line from Long Point to the north entrance of Newcomb Creek. Several tributaries to the river are also closed, water quality is degraded in St. Michaels Harbor by the STP and boat wastes, and in Oak Creek by septic tanks and boat wastes. D.O. in these areas have not met the D.O. standards during stress periods.

SOURCE: (5)

communities stem basically from their location in unsuitable soils and occasional overflows.

The open water disposal of dredged material at the Pooles and Kent Island disposal sites has continued at varying degrees for several years. Used mainly for deposition of sediments from maintenance dredging in the approach channels to Baltimore Harbor and the approaches to the C & D Canal, the disposal appears to have had no major long term impact on the water quality of the surrounding waters. Studies by the Environmental Concern Corporation for the Corps of Engineers have shown that manganese and total kjeldahl nitrogen (TKN) values of the sediments to be disposed may exceed acceptable values but that no compelling arguments can be developed to exclude either of the sites for possible future use.

In the near future nutrient loadings in the waters of the Chester River sub-basin are expected to increase. The amount of increase will depend upon population growth and the degree of treatment provided by sewage treatment plants in the upper basin area. Improvement will result, however, in the bacterial and chemical quality of water as municipal treatment plants upgrade facilities and the seafood industries improve treatment to obtain

effluent permits. Non-point sources will continue to be a problem although minor improvements can be expected with closer enforcement of boating regulations and improved farming techniques which limit runoff.

SUB-AREA UE-3–(ELK)

Description. The Elk River sub-basin, which is shown on Plate 7-1, covers most of Cecil County and part of Kent County in Northeast Maryland. The area near the headwaters has gently rolling hills and becomes increasingly level as the river approaches its mouth on the Coastal Plain. Total land and water area of the sub-basin is approximately 400 square miles. Larger tidal rivers and tributaries within the basin include the Northeast, Elk, Back Creek, C and D Canal, Bohemia, and the Sassafras.

The area is mainly agricultural with the smaller Towns of Perryville (pop. 2,091), Northeast (pop. 1,818), and Elkton (pop. 5,362) serving as the main population centers. The Route 40 corridor has the heaviest concentration of industries and most of the larger sewage treatment plants in the sub-basin. An important link between Chesapeake Bay and Delaware Bay systems is the C and D Canal and Back Creek Drainage. Averaging 35'x450', the flows and currents in the canal vary as a function of different tidal stages at both ends. However, net flow in the canal is from Chesapeake Bay to the Delaware River.

Principio Creek and all tributaries are designated Class III–natural trout waters. All estuarine portions of tributaries in the Elk River Area sub-basin are designated Class II waters for shellfish harvesting, except Elk River and tributaries above a line from Bull Minnor Point to Courthouse Point, Bohemia River and tributaries above a line from Rich Point to Baltery Point, Sassafras River and tributaries (Still Pond) above Kinnaird Point, and above the mouths of Northeast River and Worton and Fairlee Creeks. These and all other waters of this sub-basin are designated Class I for water contact recreation and aquatic and wildlife uses.

Water Quality. Table 7-21 indicates the status of the tributaries in this segment with respect to various water quality parameters and standards developed by the State of Maryland.

In general, the quality of water in this sub-basin is good. However, as in the surrounding sub-basins, chlorophyll *a* values have shown increases and algal populations have been on the rise over the past five to six years. The Class II bacteria standards have also been exceeded at certain stations along the mainstem in 1974. The resulting shellfish closures as of December 31, 1974 are listed in Attachment 7-B at the back of this appendix. Also included is an update of closings effective March 31, 1976.

Eight major municipal sewage treatment plants (average flows greater than 0.1 mgd) and several small industries discharge point source wastes into the

TABLE 7-21
WATER QUALITY IN THE ELK RIVER AREA

SEGMENT	MEETS WATER QUALITY STANDARDS				COMMENTS
	D.O.	Temp.	pH	Bacteria	
Sassafras River	yes	yes	yes	yes	Susquehanna River influence and local problems--Algae Blooms.
Elk River	yes	yes	yes	*	Susquehanna River influence--Algae Blooms and STP's. *Exceeded numerical limit in upper end Class I and small area of Class II.
Bohemia River	yes	yes	yes	*	Susquehanna River influence and local runoff. *Exceeded numerical limit in upper end--Algae Blooms.
Back Creek	yes	yes	yes	no	Chesapeake City STP's (2) to be upgraded. Algae Blooms.
Northeast River	yes	yes	yes	*	Susquehanna River and local runoff. *Exceeded numerical limit in upper end. Algae Blooms
Furnace Bay	yes	yes	yes	no	Principio Creek--naturally high occurring temperatures in trout area, agricultural area. Algae Blooms (tidal).
Stillpond Fairlee Area	yes	yes	yes	*	Agricultural area. *Exceeded numerical limit.
Christina River	yes	yes	yes	*	Agricultural area. *Exceeded numerical limit.
Crystal Beach Area	yes	yes	yes	*	Agricultural and domestic. *Exceeded numerical limit. Sanitary waste.
Elk Neck Area	yes	yes	yes	yes	A rural area.
Port Herman Area	yes	yes	yes	yes	A rural area.
Elk River Headwaters	yes	yes	yes	yes	High nutrients from runoff and discharges. Agricultural area and sanitary waste. High turbidity d during heavy runoff.
Elk Neck Bay Area	-	-	-	-	No known streams--small area.

SOURCE: (3)

water of sub-basin UE-3. A list of the municipal facilities, along with current discharge loadings, is presented in Attachment 7-A. The locations of each plant are also presented on Plate 7-1.

Several studies of municipal treatment plants in the area have indicated the need for improved effluent quality (especially BOD, bacteria, and nutrients) because of the poor quality and eutrophic conditions of the receiving waters. Nutrient reduction is scheduled within the near future for treatment facilities in Northeast, Perryville, Elkton, and other areas. Pennsylvania also is committed to reduce the high nutrient load from the Susquehanna River which also affects these tidal areas.

Industrial development in the basin is not great, nevertheless a concentration of a variety of industries along the Route 40 corridor have caused some

water quality problems. In the past these industries have contributed greatly to the contravention of the Class II bacteria standard in the Elk headwaters and mainstem. Several industrial complexes have responsed to the violations with corrective actions that have improved the overall quality of several areas, especially Little Elk Creek. The occurrence of blue-green algal blooms in several of these areas warrants continued surveillance.

Non-point sources of pollution are significant in this Basin, as most of the area is in agricultural use. Most idrectly affecting the quality of water are agricultural and urban runoff, septic system failures, and domestic wastes from recreational boating activities. The agricultural runoff problems occur mainly in the headwaters of the Region and contribute to the high volumes of nutrients and bacteria found in the sub-basin. Urban runoff problems also occur in the Perryville, Northeast, and Elkton Areas carrying high sediment loads to the receiving waters. Septic system failures in the areas east and south of Elkton and below Charlestown contribute high bacteria counts and indicate the need for better sewerage systems. Recreational boating activities in the Sassafras, Bohemia, Elk, and Northeast River Areas also contribute high bacteria levels, especially during the summer boating season.

The C & D Canal enlargement from 27′ x 250′ to 35′ x 450′ has been studied by several groups to determine the effects on flows and biological life. (25) No major problems or significant changes were foreseen. However, continued monitoring was recommended due to the ecological importance of the area. Recurring problems with the canal will continue to be associated with spoil disposal, potential oil spills, and shoreline erosion from waves generated by large ships passing through the canal area.

The expected Elk River Area water quality trend is toward improvement. However, the high chlorophyll *a* levels must be reduced before any significant advances are recognized. As corrective steps, the larger STP's (Northeast, Perryville, and Elkton) will be required to have a minimum phosphate removal efficiency of 80 percent. Smaller plants will also be required to upgrade facilities to secondary treatment (BOD, suspended solids, and chlorine control). The non-point sources should also see some improvement as enforcement of boating regulations and improved farming techniques are implemented as well as extension of sewer service to relieve areas suffering from septic tank failures.

CHESAPEAKE BAY–SUMMARY

The previous sections of this chapter have surveyed water quality conditions of the Bay's tributaries and adjacent land areas. This was done because past experience and trends have demonstrated that what occurs in the tributaries of this great estuary have the most significant impact upon the Bay itself. This short section will summarize the major water quality findings as they impact upon Chesapeake Bay.

Chesapeake Bay, as previously mentioned, is one of the largest estuaries in the world, having a surface area of about 4,400 square miles and a length of nearly 200 miles. Five major rivers, the Susquehanna, Potomac, Rappahannock, York, and James drain an area of about 64,200 square miles and provide nearly 90 percent of the total freshwater inflow to the Bay.

Characterizing the entire Bay Area's water quality in one word is difficult because of the wide variety of conditions encountered in an area of this size. However, a blanket statement would probably conclude that the water quality of the Bay itself is good, with most of the severe problems occurring in the tributaries and especially near areas of high population concentrations. Increasing loads from municipal sewage treatment plants and industrial sources, agricultural and storm runoff, and marine transportation spills are causing stresses and problems, some very severe, throughout the Bay Region. Also, from recent indications, these types of loads can be expected to continue to increase the stress on Bay waters, at least for the near future.

In the Bay itself, a problem of increasing concern is the rapidly increasing eutrophication rate in the Upper Bay Areas. Studies by the Environmental Protection Agency (EPA) during the 1969-1971 period demonstrated high nutrient and chlorophyll *a* levels with increasing values toward the end of the period. Examination of 1974 data disclosed reductions in phosphorus and chlorophyll *a* to or below values observed during the 1968-1969 period in a critical area between Pooles Island and the Chesapeake Bay Bridge. Conversely, nitrogen values were higher in 1974 than in the previous five years. As a result of these data, the State of Maryland has established a policy of 80 percent removal of total phosphorus (as P) from all point sources discharging directly into the Bay. This will place limitations on phosphorus concentrations in discharges as has been done by Pennsylvania for the Lower Susquehanna River. Improved water quality in the future is expected, particularly in the Upper Chesapeake Bay near Susquehanna Flats.

Point related sources of wastewater are growing along with associated volumes throughout the Bay Region. One-hundred and ninety major municipal sewage treatment plants (average flows greater than 0.1 mgd) have been surveyed in the Bay Region and are listed by study area in Attachment 7-A, at the back of this appendix. Figure 7-14 illustrates the cumulative design flows of treated wastewater from each of the major tributaries and at various points along Chesapeake Bay. Tidal dilution and the assimilative capacity of freshwater inflows are not accounted for by these figures.

Industrial discharges in the Bay Region are many and consist of varied types of effluents. The major industrial complexes in the Bay Area are the Baltimore Harbor Area, the Petersburg-Hopewell Area, and the Norfolk Area, which is near the mouth of the James River. No list of industrial discharges was included in this report as all flow rates and permit parameters were not available during the preparation of the report. However, the major water impacting industries have been discussed within the text material of each sub-basin.

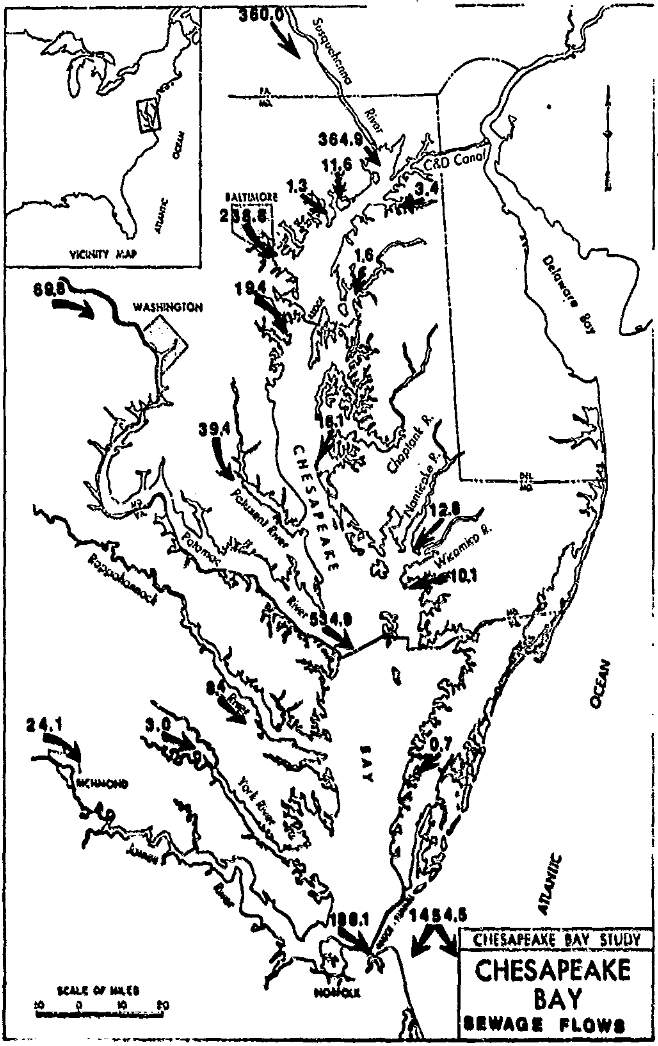


Figure 7-14: Sewage Flowrates in Chesapeake Bay (MGD)

Non-point sources of pollution in Chesapeake Bay consist mainly of sedimentation from urban and agricultural runoff, domestic wastes from boating activities, and marine transportation spills. Specific problems have been covered for each basin and in some cases, such as rural areas, the non-point pollutants appear to be the major causes of water quality degradation.

Figure 7-15 summarizes the major water quality problems of the larger tributaries and their surrounding land areas. Municipal and industrial wastes have been found to be the major problems in the populated areas of Baltimore, Washington, Richmond, and Norfolk. Other less populated areas suffer mainly from agricultural and land runoff as well as smaller amounts of municipal discharges. Several shellfish waters have been closed to harvesting as a result of violation of applicable standards. These areas are listed by sub-basin and tributary in Attachment 7-B, at the back of this appendix.

Table 7-22 summarizes the acreages closed for each of the six study areas shown in Figure 7-1. It should be noted that these totals represent those areas which are condemned strictly because of failure to meet water quality standards and that only about one-half of these areas could actually support shellfish activities of any significance.

SPORADIC SOURCES OF POLLUTION

To this point, discussion has been limited to those factors which contribute to the degradation of water quality of the Bay on a daily basis. These are very important and are perhaps the most significant when dealing with corrective measures. However, sporadic or uncommon events have degraded Bay waters in the past. Two of the most important of these are storm related floods and oil spills. Both of these contribute very heavy amounts of pollutants in short time spans and have effects which may be of long duration.

TROPICAL STORM AGNES

Tropical storms, such as Agnes in 1972, have had several impacts upon the Chesapeake Bay ecosystem. Beginning as a tropical depression off the Yucatan Coast on 15 June 1972, Agnes moved from the Gulf of Mexico, across the Southern States, over the Atlantic Ocean, and back into the States of New York and Pennsylvania. Throughout her course, Agnes caused considerable monetary damage and had several detrimental impacts upon the land and water related resources. In a report prepared by the Baltimore District Office of the Corps of Engineers, the effects of Agnes were surveyed in some detail. (26) Hydrological, geological, and biological effects as well as economic and public health impacts were reported on.

Among the effects on water quality were increased sediment loads, altered salinity patterns and high contributions of dissolved nitrogen and phos-

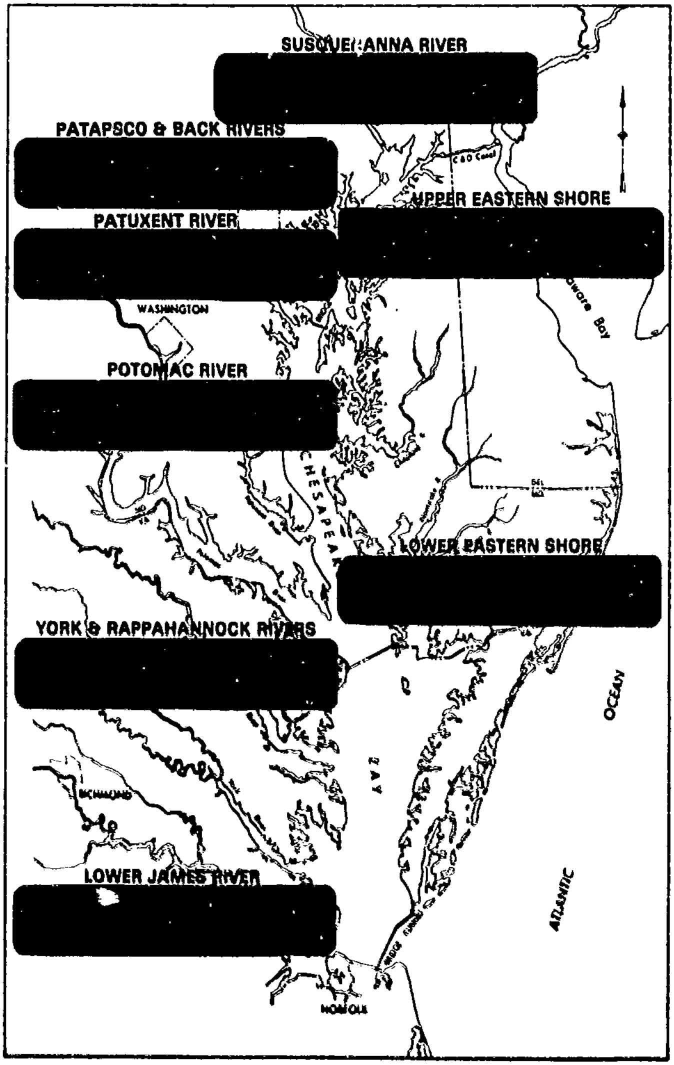


Figure 7-15: Water Quality Problems in Chesapeake Bay

TABLE 7-22
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

LOCATION	ACREAGE	CONDITIONS FOR CLOSURE
Study Area I - Baltimore	31,004	Buffer zone treatment plants Industrial pollution Stormwater runoff Boating activity
Study Area II - Washington Metro	23,482	Buffer zone treatment plants Stormwater runoff Marinas Subdivision build-up
Study Area III - Rappahannock-York	40,414	Buffer zone treatment plants Marinas Stormwater runoff Septic tank discharges
Study Area IV - James	116,791	Buffer zone treatment plants Heavy boat activities Marinas Population build-up
Study Area V - Lower Eastern Shore	14,023	Buffer zone treatment plants Boating activity Septic tanks Land runoff
Study Area VI - Upper Eastern Shore	34,359	Buffer zone treatment plants Stormwater runoff Septic tanks Boating activity
Chesapeake Bay	183,332	Buffer zone treatment plants Stormwater runoff Seasonal influx from major upstream rivers

TOTAL CHESAPEAKE BAY CLOSURES = 443,405 ACRES

Sources: Maryland - 1975 Maryland 305(b) Report, MD. DNR.
Virginia - Virginia State Department of Health, Bureau of Shellfish Sanitation

phorus. Figures 7-16, 17, and 18 show the dramatic increases in these parameters below Conowingo Dam in the Susquehanna River, the largest input of freshwater to Chesapeake Bay. River water flows increased from a 4.9×10^3 cfs low for the year to 1.1×10^6 cfs; an increase of 3,900 percent over the June non-storm period. Along with this increase were great increases in loads of pollutants. Sediment input, measured by total suspended solid content, rose by 1,800 percent (estimated at 28 tons/hour during the flood peak). Orthophosphate increased to 1,030 tons/day (1,700 percent). The biochemical oxygen demand (BOD) rose 5,000 percent and the fecal coliform by 700 percent. The dissolved oxygen sags which occurred in the Upper Bay were not observed to cause large-scale mortalities in the estuary. Trace metals and pesticide concentrations also increased in the Bay, but not to a level felt to cause excessive damage to the Bay's environment.

OIL SPILLS

Oil spills in Chesapeake Bay, aside from the 250,000 gallon Steuart spill near Tangier Island in February of 1976, have not been of the magnitude or notoriety of those in other areas of the country. However, several small and biologically damaging spills have occurred. Based on records maintained by the United States Coast Guard, the amount of oil spilled annually in the Bay has averaged 300 metric tons/year or about 60,000 to 100,000 gallons. Areas which have the highest concentrations of oil residuals and are most susceptible to spills are the Baltimore Harbor Area, the Lower York and Potomac Rivers, and the Hampton Roads and Norfolk Port Areas.

The major source of oil to the Bay however, is from chronic sources or those which contribute relatively small amounts of oil to receiving waters on a daily basis. These include: input from rivers tributary to the Bay, municipal sewage, industrial wastewater, recreational boating discharges, urban runoff, and ship generated wastes. Over 100 times more oil than is spilled accidently on an annual basis is estimated to be dumped into the Bay from these sources. They are very difficult to estimate or control, as they often enter the waters in trace amounts and occur at irregular times and places. A more complete coverage of this problem has been undertaken and is presented in the Biota section or Appendix 15 of this Chesaepake Bay *Future Conditions Report.*

Biological recovery from the effects of oil spills has shown no definite pattern as some areas have recovered rapidly and some areas have shown deleterious effects for more than a decade. The direct effects of oil spills and chronic discharges have mainly been the destruction of waterfowl and their habitats and the closure of shellfish beds and recreational swimming areas. However, oil may also have even more harmful indirect effects, including: the destruction of food chains, synergistic effects reducing marine life resistance to other stresses, and the reduction of reproductive processes. What remains unknown at this time is the severity of damage, which is dependent upon factors such as amount and concentration of oil, the type of oil, the time of year, and the prevailing weather conditions.

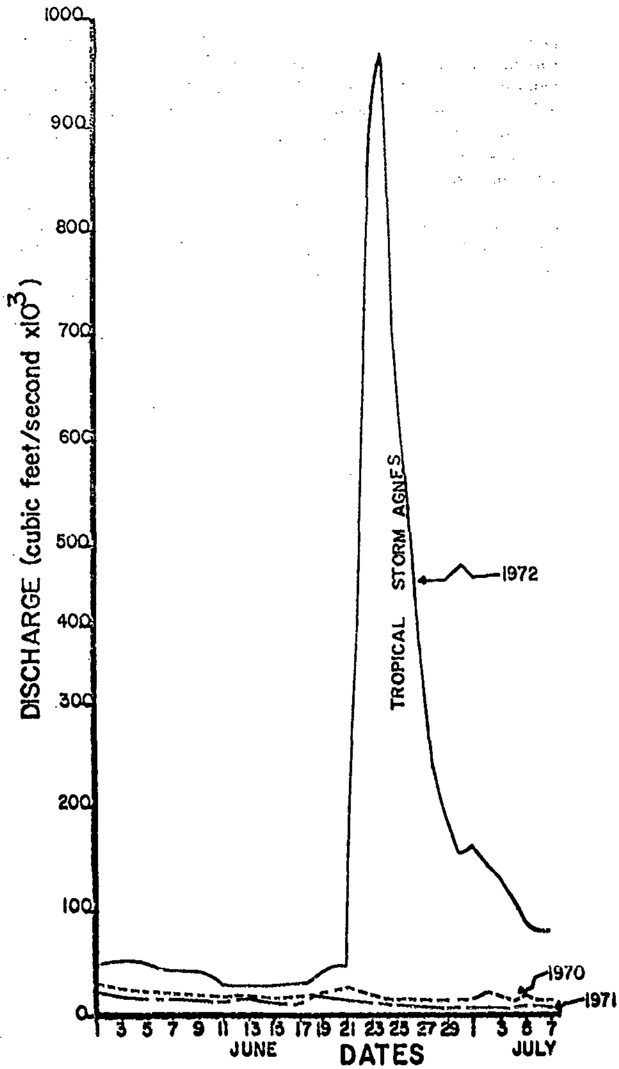


Figure 7-16: Comparative Daily Discharge Rates for the Month of June 1970, 71, 72, at Lapidum, Maryland

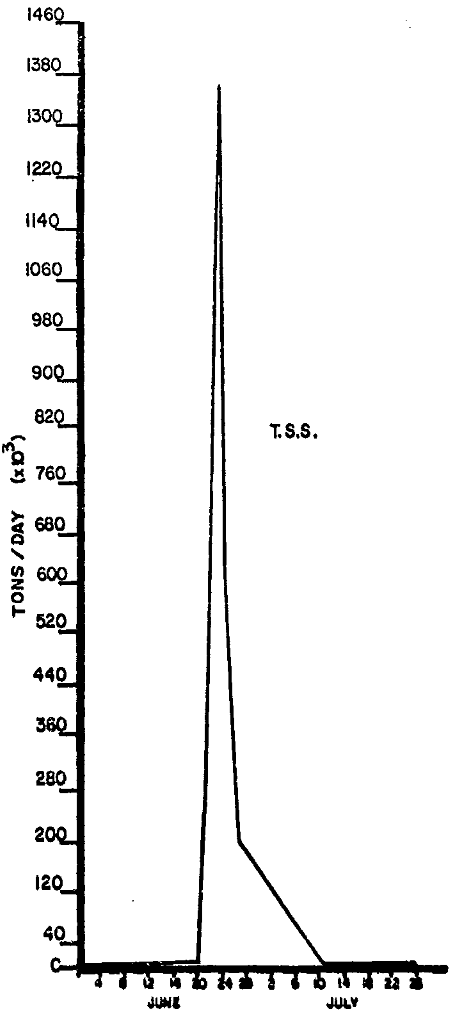


Figure 7-17: June-July 1972 Distribution Pattern of Total Suspended Solids at Lapidum, Maryland

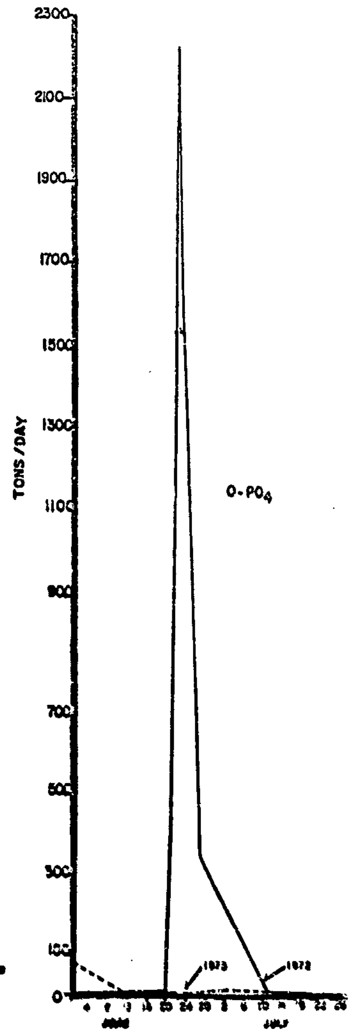


Figure 7-18: June-July 1972 Distribution Pattern of Ortho-Phosphate at Lapidum, Maryland

MANAGEMENT RESPONSIBILITIES

In the previous sections, a rather detailed discussion was presented describing the existing water quality conditions and problem areas of Chesapeake Bay and its tributaries. This section, which concludes Chapter II, seeks to identify the major congressional actions enacted to improve water quality and also to identify those Federal, State, and local agencies in the Bay Area responsible for carrying out various phases of water quality management and research.

FEDERAL ACTS RELATING TO WATER QUALITY MANAGEMENT

Several Federal acts have been passed and remain in effect since development began in the Chesapeake Bay Region and the United States. The need for Federal actions became apparent very early, as it was realized that the flow of water and its problems passed from State to State and that centralized coordination and authority would be needed to assure overall cooperation. The following paragraphs describe briefly the provisions of each Federal act enacted to deal with the management of water quality.

RIVER AND HARBOR ACT OF 1899

The 1899 Act prohibits: (1) the discharge into navigable waters or their tributaries of "any refuse matter of any kind or description whatever other than that flowing from streets and sewers and passing from there in a liquid state," and (2) the depositing of "material of any kind in any place on the bank of any navigable water or tributary where the same shall be liable to be washed into such navigable water. . .whereby navigation shall be impeded or obstructed except when permitted by the Secretary of the Army." Current judicial interpretation of the "Refuse Act" prohibits all direct and indirect discharges excepting pure unheated water into any navigable waters, unless the discharge is from a municipal or public sewage treatment system, regardless of intent, effect, or compliance with Federal water quality standards.

FEDERAL WATER POLLUTION CONTROL ACT OF 1948 (P.L. 845)

This first pollution control act was intended to involve the Federal government primarily in a supportive role. Federal funds and technical assistance were applied to strengthen local, State, and interstate water quality programs.

FEDERAL WATER POLLUTION CONTROL ACT OF 1956

This Act authorized planning, technical assistance, grants for State programs, and construction grants for municipal waste treatment facilities. The Federal Water Pollution Control Act of 1956 was subsequently amended on July 20,

1961 to extend Federal enforcement capabilities and increase construction grant authorizations.

WATER QUALITY ACT OF 1965

In 1965, the U.S. Congress passed a second amendment to the Water Pollution Control Act "to enhance the quality and value of our water resources and to establish a national policy for the control and abatement of water pollution." This law required all States to develop water quality standards for interstate waters to protect the public health and enhance the quality of water. In establishing such standards the appropriate State authority is required to take into consideration their use and value for public water supplied, propagation of fish and wildlife, recreational purposes, agricultural, industrial, and other legitimate uses.

WATER RESOURCES PLANNING ACT OF 1965

In 1965, the U.S. Congress passed the Water Resources Planning Act to provide for the optimum development of the Nation's natural resources through the coordinated planning of water and related land resources, the establishment of river basin commissions, and by providing financial assistance to the states in order to increase state participation in such planning. This Act encourages the conservation, development and utilization of water and related land resources by the establishment of a Water Resources Council, which will study and develop basin planning programs and coordinate planning efforts within each river basin through newly created river basin commissions.

NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

The purposes of the NEPA of 1969 are: "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment: to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation: and to establish a Council on Environmental Quality." The Council on Environmental Quality is required to submit an annual report to Congress relating the current status of environment; trends in the quality, management and utilization of such environment; the adequacy of available natural resources for fulfilling human and economic needs; and recommendations for improved management systems.

WATER QUALITY IMPROVEMENT ACT OF 1970

The Act states: "that it is the policy of the United States to enhance the quality and value of its water resources and to establish a national policy for the prevention, control and abatement of water pollution." This law directs

the Secretary of the Interior with the assistance from State water pollution control agencies, interstate agencies, municipalities, and industries involved, to prepare or develop comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries.

It also provides for improving the sanitary condition of surface and underground waters. Provisions for research and development and educational grants in the area of water pollution control are authorized to be used for the construction of municipal and other public water pollution control facilities.

FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972

This Act, by far, is the most effective legislation on water pollution ever passed. It extends ultimate jurisdiction of all navigable waters to the Federal government and has set as its objective the restoration and the sustenance of the chemical, physical, and biological integrity of the Nation's waters.

Several national policy statements designed to aid achievement of the objective of this act, are: (1) to eliminate pollutant discharges into navigable waters by 1985; (2) to achieve attainable interim goals toward the protection or propagation of fish, shellfish, wildlife, and recreation by July 1983; (3) to prohibit discharge of toxic pollutants in toxic amounts; (4) to provide Federal financial assistance for public waste treatment facilities; (5) to support national planning toward area-wide waste treatment management processes; and (6) to support major research and demonstration efforts towards elimination of pollutants into U.S. waters. While the act is to be administered by the EPA, the primary responsibility for its implementation, including the provision of adequate water quality standards, is to remain with individual States. However, State standards must meet EPA established guidelines, and are subject to EPA approval or revision.

STATE ACTS WHICH RELATE TO WATER QUALITY MANAGEMENT

Numerous State laws have also been passed to enhance water quality on an intrastate basis. These rules and regulations have placed direct statewide control on such water quality areas as receiving water standards, groundwater quality standards, effluent limitations, toxic material use for aquatic life management, wetland preservation, sediment control, and oil pollution prevention. As these laws vary from State to State and are numerous, they will not be presented here. However, more detailed information can be obtained from the Virginia State Water Control Board for the Commonwealth of Virginia and The Maryland Department of Natural Resources Water Resources Administration for the State of Maryland. In short, Title 8 of the Natural Resources Article, Annotated

Code of Maryland provides the basic policy to prevent water quality degradation for Maryland waters and Title 62.1 of the Code of Virginia provides similar coverage for Virginia waters.

Although a majority of the water laws are Congressionally authorized and Federal agencies such as EPA have overall responsibility for the pursual of nationwide water quality goals, the States themselves are responsible for implementation of several important sections of the Federal Acts. These responsibilities include: the promulgation and enforcement of water quality standards; the development and implementation of river basin management plans; the issuance of discharge permits for municipal and industrial point sources of pollution; and the administration of construction grants for municipal facilities. The States also have the option, through the State legislatures, to pass more stringent water quality control programs and standards. To date some of these programs have included boating discharge regulations, specialized water quality standards, combined sewer elimination programs, and water quality surveillance and monitoring programs.

CHESAPEAKE BAY WATER QUALITY MANAGEMENT AGENCIES

Several agencies within the Chesapeake Bay Area are responsible for selected phases of water quality planning and management. The following sections describe briefly each of the major agencies on a Federal, State, interstate, and local basis and their responsibilities.

FEDERAL BAY MANAGEMENT

The Department of Agriculture, through the Soil Conservation Service (SCS), has the responsibility for developing and carrying out a national soil and water conservation program. Established under the Soil Conservation Act of 1935, the SCS also assists in agricultural pollution control, environmental improvement, and rural community development.

The Department of Commerce, more specifically the National Oceanic and Atmospheric Administration (NOAA), was formed on October 3, 1970 by Reorganization Plan #4 of 1970. The mission of NOAA is to explore, map, and chart the global ocean and its living resources, to manage, use, and conserve those resources. NOAA also issues warnings against impending destructive natural events, develops beneficial methods of environmental modification, and assesses the consequences of inadvertent environmental modification over several scales of time.

The Department of Defense includes both the Departments of the Army and Navy. The U.S. Army Corps of Engineers (COE) involvement in the water quality management planning area originates from authority vested to it by the Rivers and Harbors Act of 1899. Section 10 of this legislation gives the Corps permit authority for all construction on

navigable waters. Authority is also vested in the Corps for water supply studies as contained in P.L. 89-298 (October 27, 1965) to meet the long range needs of northeastern United States. Section 312 of the Rivers and Harbors Act of 1965 also authorizes the Secretary of the Army to make a complete investigation and study of water utilization and control of the Chesapeake Bay Basin. The Navy operates a number of large installations in the Chesapeake Bay Region, including the Naval Academy, the Norfolk Naval Station, and the Patuxent Naval Air Test Center. Responsibility in the water quality area lies mostly on the control program required for pollution from the larger ships of the Naval fleet.

The U.S. Department of Interior, through many bureaus, maintains planning and technical competence in the areas of fisheries, mines, outdoor recreation, wildlife, geologic and water resources, and national parks. Of particular concern to water resources are the Office of Water Resources Research which administers the Water Resources Research Act of 1964 by stimulating and sponsoring research and training in the fields of water resources, and the Water Resources Council which prepares a biennial assessment of water supplies, reviews comprehensive river basin plans with special regard to the efficiency of these plans in achieving optimum use of the resources, and assists the States in increasing water resource planning capabilities.

The United States Coast Guard (USCG), part of the Department of Transportation, is responsible for enforcing Federal laws on the high seas and navigable waters of the United States. Enforcement of regulations for overboard dumping of domestic wastes, which were developed by the USCG and EPA under Section 312 of the Federal Water Pollution Control Act Amendments of 1972, is also the responsibility of the USCG.

The U.S. Department of Health, Education, and Welfare (HEW) through the National Institutes of Environmental Health Services, conducts research on the biological effects of chemical, physical, and biological substances in the environment.

The Environmental Protection Agency (EPA), established on December 2, 1970, has the prime responsibility for regulating and implementing all Federal activities in its comprehensive effort against pollution. EPA's regulatory activities are vested primarily through the 1972 FWPC Act Amendments. EPA has extensive funding powers for construction of waste treatment facilities and supports research by other agencies through grants and contracts.

EPA has been directed, in connection with its responsibilities under the Federal Water Pollution Control Act Amendments of 1972 and authorization by the Department of Housing and Urban Development –

Independent Agencies Appropriations Bill of 1976, to "conduct an indepth study of Chesapeake Bay which shall be applicable to other estuarine zones." Based upon additional Congressional guidance and coordination with other agencies involved in studying Chesapeake Bay, the primary goal of the study will be to develop a management system which is designed to maintain and improve the water quality of the Chesapeake Bay. The long-term objectives of the study are as follows:

- Develop the institutional-technical framework to implement an effective water quality management system for the Bay;
- Establish an effective and continuing Bay-wide monitoring system to collect, store, and analyze sampling data;
- Establish the appropriate focal point to coordinate an information system to assemble and disseminate technical and monitoring information relative to the Bay;
- Establish a broader pollutant data base in order to strengthen enforcement programs;
- Recommend where necessary, alternative Chesapeake Bay water quality management mechanisms and authorities which may require legislative action.

The EPA study was initiated in March of 1976 with a study development period to establish policies, advisory groups, conferences, and the plan of study. The implementation phase, which began in FY 1977, marked the beginning of the actual research and development of the management program. The management responsibility for this study lies with the Regional Administrator of the Region III office of EPA.

The Energy Research and Development Administration (ERDA) was established by the Energy Restoration Act of 1974 and officially activated on January 19, 1975. The main responsibility of ERDA in the Chesapeake Bay Region is nuclear research and development activities formerly handled by the Atomic Energy Commission. Regulatory functions of nuclear power plant programs are now being handled by the Nuclear Regulatory Commission (NRC), a separate agency also authorized under the Energy Reorganization Act of 1974.

The Federal Power Commission (FPC) regulates the interstate aspects of electric power and natural gas industries. Under the authority of the Federal Water Power Act of June 10, 1920 and amendments in 1935 and 1938, the FPC issues permits and licenses for non-Federal hydroelectric power projects and requires maximum feasible protection of our natural environment in the construction of these projects.

INTERSTATE BAY MANAGEMENT AGENCIES

The Interstate Commission on the Potomac River Basin (ICPRB) was established by Congress for the purpose of regulating, controlling and preventing pollution of the Potomac and fostering the integration and coordination of planning for the development and use of the water and associated land resources. The Compact which was established by act of Congress in 1940 is between Maryland, Pennsylvania, Virginia, West Virginia, and Washington, D.C.

The Susquehanna River Basin Commission (SRBC) is a Federal Interstate Compact organization consisting of the U.S. Government and the States of Maryland, New York, and the Commonwealth of Pennsylvania. The SRBC was created by act of Congress approved December 24, 1970, and by laws adopted by Maryland, New York, and Pennsylvania. Under the terms of the Compact, the SRBC is responsible for the development and maintenance of a comprehensive plan and for programming, scheduling, and controlling projects and water resource related activities within the Susquehanna River Basin.

STATE BAY MANAGEMENT AGENCIES

Agencies within the State of Maryland and the Commonwealth of Virginia have been designated by their governors to develop, coordinate, and approve water quality management and planning based on available expertise and existing jurisdictional authority.

Maryland. The Maryland Water Resources Administration (WRA) of the Department of Natural Resources has the responsibility to "protect, enhance, and manage the water resources of the State." Specific responsibilities include: (1) water supply appropriations, (2) preparation of water quality standards, (3) the issuance of discharge and wetland permits, (4) the enforcement of water control programs, (5) the review of county water and sewerage plans, (6) the assistance in preparation and distribution of river basin water quality management plans.

The Maryland Environmental Service (MES), also part of the Department of Natural Resources, aids local governments, counties, regions, and industries in solving problems of water supply and the disposal of liquid and solid wastes, although no regulatory powers now exist. Specific responsibilities include: (1) the operation of treatment facilities for sewage, solid waste and water supply, (2) the review of county water and sewerage plans and (3) the input of technical services and information to concerned agencies (44).

The Environmental Health Administration (EHA) Department of Health and Mental Hygiene directs the efforts to safeguard the public health

against potential threats arising from environmental deterioration. The Division of Water and Sewerage conducts the control programs directed toward assurance of safe potable water supplies and adequate treatment of sewage. The Division also approves County Water and Sewerage Plans, assists in the preparation of River Basin Plans, trains sewage plant operating personnel, and coordinates planning and construction of treatment facilities including administration of Federal construction grant program (45).

The Department of State Planning functions as the Governor's staff agency in planning matters and prepares, recommends, and revises as necessary an integrated program for development of the State's natural and other resources. The Department prepares the State's capital program and annual capital budget. It also cooperates with and provides planning assistance to county, municipal, or other local governments (45).

Virginia. The Virginia State Water Control Board (VSWCB) is responsible for "assuring water quality, water supply, and flood protection in the Commonwealth, and is the administrator of the State Water Control Law." Specific statewide responsibilities and activities include: (1) planning effort and final river basin plan preparation, (2) water quality data gathering and monitoring, (3) waste load allocation and modeling, (4) priority setting and (5) compliance monitoring (45).

The Division of State Planning and Community Affairs (DSPCA) has the following State-wide responsibilities: (1) preparation of demographic studies and population projections, (2) development of land use plans and (3) integration of these plans on a comprehensive State-wide basis (45).

The Virginia Department of Health through the Division of Local Health Services administers the operation of local health districts. Their responsibilities are: (1) permitting and supervising installation of septic tanks, (2) supervision of the correction of pollution sources discovered by the Bureau of Shellfish Sanitation, (3) supervision of operation at solid waste disposal sites, (4) supervision of sanitary facilities at marinas and (5) testing and recommending local recreational waters. The Bureau of Sanitary Engineering also coordinates planning and construction of major waste disposal systems and provides input in the preparation of River Basin Plans (45).

LOCAL BAY MANAGEMENT AGENCIES

In Maryland, the county executives are responsible for the preparation, adoption, and implementation of comprehensive water and sewerage master facility plans as stated in paragraph 387C of Article 43, Annotated Code of Maryland. The objectives of these plans are to guide the

development of water and sewerage systems so that an adequate supply of high quality water may be collected, treated, and delivered to points of use, and so that wastewater may be collected, treated, and disposed of by the most economical and environmentally acceptable means.

In Virginia, Planning District Commissions have been established under the authority of the Virginia Area Development Act of 1968. The 22 established commissions, comprised of whole counties and cities in a centralized metropolitan area, are now working in cooperation with local governments to provide coordination and joint planning. Water quality management planning within each planning district has been based on planning guidelines issued by EPA, the Department of Housing and Urban Development (HUD), and the State Water Control Board (SWCB).

CHAPTER III

FUTURE WATER QUALITY NEEDS

The previous chapter has presented a rather detailed description of existing water quality conditions in the Chesapeake Bay Region. Both point and non-point sources of pollution were identified and serious water quality problem areas noted. Significant pollution control acts and agencies responsible for management of the Bay's waters were also identified, concluding the chapter.

In predicting future water quality conditions, several basic assumptions must be accepted. Since man's activities have been shown to be the major cause of both past and present pollution problems, the major pollution problems of the future can be expected to occur around areas of high population concentrations and industrial development. Obviously, it is here that most of the clean-up efforts will have to be concentrated. Future years will certainly present increased population concentrations and development throughout the entire Chesapeake Bay Region. Wastewater volumes and loadings will also inevitably increase, having the potential for severe degradation of Bay waters far beyond and worse than those existing now. However, this need not and should not occur if proper planning and implementation of advanced wastewater policies, procedures, treatment capabilities, and enforcing laws and regulations are used to their fullest.

This chapter will present data, where available, on the projected needs of Chesapeake Bay with respect to water quality and its management. Anticipated municipal wastewater flows and loadings, taken from the 303(e) State River Basin Plans currently being prepared, are presented on a Study Area basis. Industrial discharge flows are then presented on a Bay-wide basis. A presentation of the objectives or water quality standards for the waters of each State are then followed by an assessment of the anticipated needs and problem areas on a Bay-wide basis. Finally, a sensitivity analysis, which will assess and discuss the accuracy of predictions made earlier, concludes the coverage of this chapter.

PROJECTED WASTEWATER FLOWS AND LOADINGS

The best tool for determining future water quality needs, at this point in time, is to project anticipated wastewater volumes and BOD loadings. This process determines, for any specified area, what capacity and degree of treatment will be necessary to assure compliance with water quality standards. Actual predictions of temperature, dissolved oxygen concentrations, nutrient content, and turbidity are, at best, in their early stages of development and are beyond the scope of this report and most

broad-based river basin studies. The purpose of this section is to assess the future by first presenting the basic assumptions and methodologies of the projections, the anticipated municipal wastewater flows and loadings by sub-basin, the industrial wastewater flows for the entire Chesapeake Bay Area, and a brief discussion of the non-point related sources of pollution.

GENERAL ASSUMPTIONS AND METHODOLOGY

As mentioned in the chapter introduction, several basic assumptions are necessary in projecting future conditions. The most significant assumption, and the one on which all projections presented herein are based, is that each State river basin planning agency would best be able to assess projection factors and present truly representative wastewater projections. Therefore, all other assumptions made by these agencies have been accepted as valid and the data appear as they have been presented in the available 303(e) River Basin Reports of each area. Specific assumptions, and the differences between each, are presented prior to the tabulation of data in both the municipal and industrial sections.

The methodology used for projecting wastewater flows and loadings is a relatively straightforward computational process. Municipal projections can be prepared on a local basis and are therefore presented for most of the study sub-areas of Chesapeake Bay. Industrial projections are slightly more complicated and are closely tied to the economy of a larger area and the water supply problem. These projections are compiled and presented on a Bay-wide basis. The methodology for industrial projections, because of their differing approach, will not be presented here but can be found in the industrial wastewater flows section later in this chapter.

Future municipal wastewater flows are usually estimated by deciding upon a value of wastewater flow per person and multiplying by the expected population to be served in a given area. The flow per person, or gallon per capita per day (gpcd) is based on historical data and the best estimation of what can reasonably be expected to occur in the future. Several factors including infiltration/inflow, stormwater runoff, and the addition of industrially pre-treated wastes can greatly increase the gpcd and as a result the expected flow. In general, reduction in gpcd usually results in better treatment with existing facilities. Choice of population projections are also very important in this procedure, as errors can lead to very high or low flowrates. For the river basins of the Chesapeake Bay Area, the overall population growth projections were provided by the Bureau of Economic Analysis (BEA) projections. These projections were based on the Bureau of the Census SERIES E fertility assumptions. Significant deviations from this base data or disaggregations of county population data into wastewater service areas

have, however, been permitted by EPA Water Quality Planning Guidelines in order to more adequately reflect differing river basin conditions.

Future municipal wastewater loadings can be estimated by two basic methods. Raw influent wasteloads, measured in pounds per day (lb/dy) of Biochemical Oxygen Demand (BOD) can be computed by assuming a BOD loading per person per day (lb/dy) and multiplying by an expected service area population. They may also be computed by assuming a typical concentration of influent BOD (mg/1) and multiplying by the projected flowrate and a conversion factor to obtain a BOD loading (lb/dy). Both assumptions are based on typical concentrations of wastewater influent and factors such as the addition of garbage disposal units and industrial connections which may increase the per capita BOD loading. Projected effluent loadings are based upon final effluent limitations required by current discharge permits. This concentration in mg/1 assumes a constant level of treatment for each facility and is multiplied by the flowrate and a conversion factor to obtain the loading to the river in lb/dy.

A typical municipal wastewater flow and loading projections is shown in Table 7-23. All numbers generated in the table do not apply to any specific area of Chesapeake Bay and are presented solely for exemplary purposes. In this example, populations served for the years 1980, 2000, and 2020 were chosen. An assumed gpcd usage rate of 100 gpcd in 1980, 110 in 2000, and 120 in 2020 were selected and multiplied by population served to obtain future flowrates. The BOD loading has been divided into two columns for this example only. Column A represents the influent or projected raw wasteload, which is a product of the projected population and a typical per capita wasteload concentration, assuming a 0.20 lb/cap/dy loading for 1980, a 0.23 lb/cap/dy for 2000, and a 0.25 lb/cap/dy for 2020. Column B reflects the effluent or actual discharge loading and is the product of a typical discharge permit concentration of 30 mg/l, the projected wastewater flowrate, and the concentration (mg/l) to loading (lb/dy) conversion factor of 8.34. It should be noted that both columns are not normally presented and that they are shown here only to illustrate the procedure used.

MUNICIPAL WASTEWATER FLOWS AND LOADINGS

The following sections present, by study area, a summary of the latest available information concerning projected municipal wastewater flows and loads. Because of differing types of data and assumptions, a short introductory paragraph documenting the sources of information and specific assumptions or procedures is presented prior to each table. For those river basins in which no data was available as of 1 August 1976, no tables will be presented.

TABLE 7-23
PROJECTED MUNICIPAL SEWAGE FLOWS AND LOADINGS

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD LOADING (lb/dy) COL. A	COL. B
Receiving Waters	An STP	1980	12,000	100	1.20	2,400	300
		2000	20,000	110	2.20	4,600	550
		2020	38,000	120	4.62	9,500	1,156

STUDY AREA 1–BALTIMORE

Lower Susquehanna River Basin. Table 7-24 presents the projected municipal wastewater flows and discharge or effluent loadings for the Lower Susquehanna River Basin in the years 1980 and 1995 as summarized from the Lower Susquehanna River Basin 303(e) Water Quality Management Plan.(27) The projected loadings are based upon population figures and per capita flow estimates agreed upon between the Maryland Water Resources Administration, the Department of State Planning and local governments. Specific assumptions and methodologies include:

1) that gpcd rates are based on historical rates and will stay constant in the future, i.e., no increases;

2) that excessive inflow/infiltration will be cut in half through conservation measures;

3) that future flows (gpcd) were derived by dividing 1/2 of the excess infiltration/inflow by the population served and adding to the existing gpcd. In the case of Havre de Grace, this procedure was altered because greater reductions than 1/2 of the existing infiltration/inflow can be expected;

4) that projected effluent loadings are based upon final effluent limitations required by current discharge permits.

Bush River Basin. No Data.

Gunpowder River Basin. No Data.

Patapsco-Back River Basin. Table 7-25 presents the projected municipal wastewater flows and discharge or effluent loadings for the Patapsco-Back River Area in the years 1983 and 1990 as summarized from the Draft Patapsco-Back River Basin 303(e) Water Quality Management Plan.(6) These loadings are based upon population figures and per capita

TABLE 7-24
PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE LOWER SUSQUEHANNA RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Susquehanna River (Below Dam)	Port Deposit	1980	1,000	85	.085	7.1
		1995	1,500	85	.128	10.6
Octorare Creek	Rising Sun	1980	1,225	105	.129	10.7
		1995	2,250	105	.240	19.9
Havre de Grace Area	Havre de Grace	1980	1,300	110	1.430	283.2
		1995	1,500	110	1.650	274.9
Furnace Bay	Perryville	1980				
		Domestic	3,000	120	.360	
		Industrial	-	-	.185	
		V.A. Hosp.	-	-	.530	
					1.075	89.5
		1995				
		Domestic	4,500	120	.540	
		Industrial	-	-	.185	
		V.A. Hosp.	-	-	.530	
					1.255	104.5
TOTALS		1980	6,525	105	2.719	390.0 Avg. (98)
		1995	9,750	105	3.273	410.0 Avg. (102)

SOURCE: (27)

flow estimates developed and agreed upon by the Baltimore Regional Planning Council, the Maryland Water Resources Administration, and local city and county water and sewerage authorities.

Specific assumptions and methodologies include:

1) that secondary treatment techniques will remain in effect throughout the study period;

2) that gpcd rates are based on historical data and will remain constant at 135 gpcd for all plants;

3) that the projected effluent loads are based on average effluent concentrations as monitored historically by Maryland Department of Health and Mental Hygiene;

4) Patapsco STP effluent concentration–30 mg/l;

5) Cox Creek STP effluent concentration–16 mg/l;

TABLE 7-25
PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE PATAPSCO RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD₅ LOADING (lbs/day)
Patapsco River	Patapsco STP	1983	477,000	135	68.0	17,000
		1990	576,200	135	81.0	20,300
	Cox Creek STP	1983	93,600	135	14.0	1,900
		1990	130,400	135	18.0	2,400
Back River*	Back River STP	1983	1,153,200	135	60.0 A.S. 99.0 T.F. 159.0 TOT.	27,500
		1990	1,229,200	135	60.0 A.S. 106.0 T.F. 166.0 TOT.	28,800
TOTALS		1983	1,723,800	Avg. 135	232.5	Avg. 26,400 (8,800)
		1990	1,935,800	135	261.6	31,500 (10,500)

* Includes flows to Bethlehem Steel Corporation.
A.S. - Activated Sludge
T.F. - Trickling Filter

SOURCE: (6)

6) Back River STP effluent concentrations:

23 mg/l for Trickling Filter units
17 mg/l for Activated Sludge units

West Chesapeake River Basin. Table 7-26 presents the municipal wastewater flows and discharge or effluent loadings for the West Chesapeake River Basin in the years 1980 and 2000 as summarized from the West Chesapeake River Basin 303(e) Water Quality Management Plan.(28) The projected flows and loadings are based upon population projections and sewer service areas developed by the Anne Arundel and Calvert County Water Sewerage Authorities.

Specific assumptions and methodologies include:

1) that future per capita consumption rates may be either 80, 100, or 125 gpcd. Historical consumption rates have not yet been determined and use of specific rates reflects the best estimate by the local authority.

2) that projected effluent loadings are based on average effluent concentrations as monitored by the Maryland Department of Health and Mental Hygiene and valid discharge permit limitations developed through 1980.

TABLE 7-26
PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE WEST CHESAPEAKE RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD5 LOADING (lbs/day)
Chesapeake Bay	Broadneck STP	1980	28,304	100	3.03	505
		2000	140,338	100	14.65	2,444
Severn River	Annapolis, City of	1980	61,299	125	8.46	1,411
		2000	96,440	125	13.80	2,302
Granville Creek South River	Sylvan Shores WWTP	1980	228	100	.02	8
		2000	2,485	100	.25	42
	Woodland Beach STP	1980	2,396	100	.24	40
		2000	5,346	100	.54	—
Chesapeake Bay	Mayo WWTP	1980	8,337	100	.83	138
		2000	17,042	100	1.70	284
	Broadwater STP	1980	3,410	100	.34	57
		2000	9,041	100	.90	151
	Rosehaven STP	1980	1006	100	0.10	8
		1995	1185	100	0.12	10
	Chesapeake Beach	1980	2000	100	0.20	61
		1995	4040	100	0.40	67
	North Beach	1980	900	100	0.09	15
		1995	1350	100	0.13	22
Parker Creek, Chesapeake Bay	Prince Frederick WWTP (includes residential, industrial and chemical demands)	1980	1500	100	0.15	12
		1995	3530	100	0.35	29
	TOTALS	1980	109,380	Avg. 102	13.461	2,255 (Avg) (226)
		2000	280,817	102	32.844	5,351 (594)

SOURCE: (28)

TABLE 7-27

PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE PATUXENT RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Patuxent River	Parkway WWTP	1980 2000	46,920 71,300	125 125	7.50 11.3	626 943
	Bowie WWTP	1980 2000	33,000 34,000	100 100	3.0 3.0	250 250
	Horsepen WWTP	1980 2000	5,840 8,400	125 125	0.78 1.14	65 95
	Solomons Island WWTP	1980 2000	5,000 12,000	100 100	0.4 0.9	34 75
Western Branch	Western Branch WWTP	1980 2000	103,770 259,970	125 125	15.4 38.5	1,251 3,211
Little Patuxent River	Savage WWTP	1980 2000	117,000 239,200	100 100	12.3 25.1	1,026 2,094
	Patuxent WWTP	1980 2000	20,000 67,000	125 125	3.1 8.4	259 701
Patuxent River	Pine Hill Run WWTP	1980 2000	24,800 41,200	100 100	3.0 4.8	250 400
	Maryland City WWTP	1980 2000	13,583 25,316	125 125	1.7 3.2	142 267
	TOTALS	1980 2000	369,913 758,116	Avg. 114 114	67.18 96.34	(Avg) 3,903 (434) 8,046 (894)

SOURCE: (29)

Patuxent River Basin. Table 7-27 shows the projected municipal wastewater flows and discharge or effluent loadings for the Patuxent River Basin in the years 1980 and 2000 as summarized from the Patuxent River Basin 303(e) Water Quality Management Plan.(29) The projected flows and loadings are based upon population figures, sewage service areas, and per capita flow estimates made by the local and county water sewerage authorities. Among the specific assumptions and methodologies are:

1) that per capita consumption rates are based on historical data and have been estimated at 100 gpcd for Howard, Calvert, Charles, and St. Mary's Counties and 125 gpcd for Montgomery, Prince Georges, and Anne Arundel Counties. The 125 gpcd figures reflect 100 gpcd plus flow factors for infiltration, industry, and commercial development;

2) that projected effluent loadings are based on average effluent concentrations as monitored by the Maryland Department of Health and Mental Hygiene and valid discharge permit limitations developed through 1980. (10 mg/1)

TABLE 7-28

PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE WASHINGTON METROPOLITAN AREA

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_4 LOADING (lbs/day)
Potomac Mainstem River Mile 152.0	Montgomery County STP	1980	--	--	32.6	2,719
		2000	--	--	88.5	7,381
Potomac Mainstem River Mile 95.3	Blue Plains STP	1980	--	--	309.0	25,800
		2000	--	--	309.0	25,800
Piscataway Creek	Piscataway STP	1980	--	--	25.8	2,152
		2000	--	--	146.3	12,201
	TOTALS	1980	--	--	367.40	30,671 (Avg.) (10,224)
		2000	--	--	543.80	45,382 (15,127)

SOURCE: (14)

STUDY AREA II--POTOMAC

Washington Metropolitan Area. Table 7-28 presents the available data concerning the projected municipal wastewater flows and discharge or effluent loadings for the Washington Metropolitan Section of the Potomac River Basin for the years 1980 and 2000 as summarized from the Washington Metropolitan 303(e) Water Quality Management Plan.(14) The projected loadings and flows are based upon population projections, per capita usage rates, and service areas developed by the Maryland National Capital Parks and Planning Commission (MNCPPC) and the Washington Suburban Sanitary Commission (WSSC).

Initial computations were based upon service areas and per capita use rates of the small drainage basins within the study area. Breakdowns of these flowrates to the three major sewage treatment plants in the area are based on the existing capacities and configurations of interceptors and are rather involved. As a result, population served and gpcd, which were not readily available, are not presented in the following table. The flowrates which are presented depend directly on allocations decided upon by the local governments and may change in the future as allocation and cost-sharing negotiations continue. The projected effluent or discharge loadings are based upon average effluent concentrations as monitored by the Maryland Department of Health and Mental Hygiene and valid discharge permit limitations developed through 1980. (10 mg/l)

TABLE 7-29

PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN THE NORTHERN VIRGINIA AREA

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Goose Creek	Pimmit Run	1979	59,800	100	5.98	10,200
		2000	84,600	114	9.64	14,400
		2020	121,000	125	15.1	20,600
	Scott Run	1979	14,300	100	1.43	2,430
		2000	21,000	114	2.39	3,570
		2020	26,000	125	3.25	4,420
	Difficult Run	1979	65,000	100	6.5	11,100
		2000	134,200	114	15.30	22,800
		2020	178,900	125	22.4	30,400
	Sugarland Run	1979	38,800	100	3.88	6,600
		2000	63,500	114	7.24	10,800
		2020	119,200	125	14.9	20,300
	Broad Run	1979	6,000	100	0.60	6,690
		2000	19,000	114	2.17	30,400
		2020	50,000	125	6.25	52,600
	Leesburg	1979	18,500	100	1.85	3,150
		2000	46,500	114	5.30	7,900
		2020	97,000	125	12.1	16,500
Four Mile Run	Arlington	1979	201,600	120	24.2	34,300
		2000	249,950	146	36.5	42,500
		2020	294,700	146	43.0	50,000
Cameron Run	Westgate	1979	99,700	131	13.1	17,000
		2000	143,170	133	19.0	24,300
		2020	200,000	134	26.8	34,000
	Alexandria	1979	188,230	131	24.7	32,000
		2000	267,300	133	35.6	45,400
		2020	370,000	134	49.6	62,900
Little Hunting and Dogue Creeks	Little Hunting Cr.	1979	50,200	100	5.02	8,350
		2000	79,300	114	9.05	13,480
		2020	110,000	125	13.8	18,700
	Dogue Creek	1979	36,000	100	3.60	6,120
		2000	67,650	114	7.70	11,500
		2020	90,000	125	11.3	15,300
	Fort Belvoir	1979	25,000	100	2.50	4,250
		2000	36,300	114	4.14	6,170
		2020	40,000	125	5.00	6,800
	Lower Potomac	1979	158,800	100	15.9	27,000
		2000	287,100	114	32.7	48,800
		2020	464,000	125	58.0	78,800
Upper Occoquan	Haymarket	1979	1,150	100	0.115	196
		2000	5,550	114	0.633	943
		2020	7,900	125	0.990	1,340
	Gainesville	1979	1,150	100	0.115	196
		2000	5,550	114	0.633	943
		2020	7,900	125	0.990	1,340
	Nokesville	1979	2,500	100	0.25	425
		2000	5,250	114	0.599	893
		2020	7,000	125	0.875	1,190

Table 7-29 (Continued)

PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN NORTHERN VIRGINIA AREA [1/]

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Upper Occoquan (Continued)	Brentsville	1979	1,000	100	0.100	255
		2000	3,500	114	0.399	595
		2020	5,000	125	0.625	850
	Lake Jackson	1979	1,500	100	0.150	---
		2000	3,500	114	0.399	---
		2020	5,000	125	0.625	---
	Manassas	1979	72,000	100	7.20	12,200
		2000	133,000	127	16.9	22,610
		2020	207,000	130	26.9	35,200
Occoquan River	Potomac Plant OWSD-DTSC	1979	65,000	100	6.50	11,100
		2000	118,820	114	13.6	20,200
		2020	207,000	130	26.9	35,200
	Dale City #1	1979	15,000	100	1.50	2,550
		2000	19,685	114	2.24	3,350
		2020	26,000	125	3.25	4,420
	Dale City #8	1979	15,000	100	1.50	2,550
		2000	26,450	114	3.02	4,500
		2020	44,000	125	5.50	7,480
	Quantico	1979	15,000	100	1.50	2,550
		2000	17,300	114	1.97	2,720
		2020	16,000	125	2.00	2,720
	Lorton	1979	9,600	100	0.96	1,630
		2000	14,350	114	1.64	2,440
		2020	15,000	125	1.88	2,550
North Fork Goose Creek	Round Hill	1979	2,000	100	0.20	340
		2000	3,700	114	0.422	629
		2020	4,500	125	0.563	765
	Purcelville	1979	4,500	100	0.45	765
		2000	9,000	114	1.04	1,530
		2020	12,000	125	1.50	2,040
	Hamilton	1979	2,700	100	0.27	459
		2000	5,300	114	0.605	901
		2020	8,000	125	1.00	1,360
	St. Louis	1979	450	100	0.045	77
		2000	900	114	0.104	153
		2020	1,500	125	0.188	255
	Middleburg #1 & #2	1979	2,400	100	0.240	
		2000	5,500	114	0.627	936
		2020	9,000	125	1.13	1,530
Catoctin Creek	Lovettsville	1979	1,150	100	0.115	196
		2000	2,350	114	0.269	399
		2020	5,000	125	0.625	850
	Waterford	1979	600	100	0.060	102
		2000	1,750	114	0.200	298
		2020	2,500	125	0.313	425
	Paeonian Springs	1979	1,050	100	0.105	179
		2000	2,400	114	0.264	408
		2020	3,500	125	0.440	595

TABLE 7-29 (Continued)
PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN NORTHERN VIRGINIA AREA

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD₅ LOADING (lbs/day)
Aquia Creek	Aquia Creek	1979	14,000	128	1.80	2,380
		2000	31,750	129	4.08	5,400
		2020	52,000	130	6.77	8,840
	S. Stafford	1979	--	--	--	--
		2000	625	114	0.071	106
		2020	1,000	125	0.125	170
Upper Machodoc Creek	Dahlgren	1979	2,000	135	0.27	340
		2000	3,750	134	0.431	638
		2020	7,000	134	0.939	1,190
Monroe Bay	Colonial Beach	1979	4,300	130	0.560	731
		2000	5,650	139	0.785	961
		2020	8,200	146	1.20	1,160
Lower Machodoc Creek	Machodoc-Kinsale	1979	--	--	--	--
		2000	6,097	113	0.69	1,026
		2020	7,500	125	0.937	1,275
Yeocomico River	Callao	1979	--	--	--	--
		2000	1,775	114	0.202	302
		2020	2,000	125	0.250	340
	Heathsville	1979	--	--	--	--
		2000	625	114	0.07	106
		2020	800	123	0.10	136
	TOTALS			(Avg.)		Avg.
		1979	1,195,980	105	133.26	208,828 (6,142)
		2000	1,933,697	117	238.62	355,034 (9,343)
		2020	2,798,640	127	363.32	519,536 (13,672)

SOURCE: (15)

Lower Potomac Area. No data.

Northern Virginia Area. Table 7-29 presents the projected municipal wastewater flows and raw influent loadings for the Northern Virginia Area for the years 1979, 2000, and 2020, as summarized from the Potomac-Shenandoah 303(e) Water Quality Management Plan. (15) The projections are based on medium rates of population growth developed by the Virginia Department of State Planning and Community Affairs (DSPCA) and service areas designated by the Northern Virginia, RADCO, and Northern Neck Planning District Commissions. Specific assumptions and methodologies include:

a. That per capita consumption rates in treatment plants without large infiltration/inflow or industrial input have average 100 gpcd. Future flows have been established on an expected 0.5 percent increase per year throughout the study period. Also, the GPCD may be observed to decrease as infiltration/inflow reductions occur.

b. That the projected raw or influent wasteloads are based on an average concentration of 0.17 lbs. BOD/cap/day for 2020. These increases have been justified on the basis of additional light to medium industrial connections and the increased use of garbage disposal units.

STUDY AREA III–RAPPAHANNOCK-YORK

Tables 7-30 and 7-31 present the projected municipal wastewater flows and raw or influent loadings for both the Rappahannock and York River Basins for the years 1980, 2000, and 2020. It is important to note that these figures are based on the medium range population projections made by the Virginia Department of State Planning and Community Affairs (DSPCA) which were broken down into hydrologic units by the Virginia State Water Control Board (SWCB). The counties and cities shown in the table are only those portions of that county which are within the drainage basin of either the York or Rappahannock Rivers. Most important is the fact that these figures represent total populations and not the percentages served by regional plants. Therefore, the figures may be somewhat higher than expected, due to the lack of an attenuation factor for those areas expected to be served by septic systems. Specific assumptions and methodologies include:

a. That gpcd consumptions rates are based on historical data and that future rates are computed by the addition of an average increase of 1.5 gallons per capita per year. In the absence of data, the Virginia Department of Health design value of 100 gpcd was used as a starting point. For this report, the gpcd rates were derived from information supplied in the Phase I Addendums of both the York and Rappahannock State River Basin Water Quality Management Plans. (17)(18)

b. That the projected raw or influent wasteloads are based on an average concentration of 0.17 lbs/capita/day. Future per capita loadings have been designated as 0.20 lbs/capita/day for 1980, 0.23 lbs/capita/day for 2000, and 0.25 lbs/capita/day for 2020. These increases have been justified on the basis of additional light to medium industrial connections and the increased use of garbage disposal units.

STUDY AREA IV–LOWER JAMES

Table 7-32 presents the projected municipal wastewater flows and raw waste or influent loadings for the Lower James River Basin for the years 2000 and 2020 as summarized from the Lower James Comprehensive Water Quality Management Study of 1974 (21). The projected loadings are based upon population figures and per capita flow estimates derived by the Virginia Department of State Planning and Community Affairs (DSPCA) and agreed upon by the Richmond, Crater, Peninsula, and Southeastern Planning Districts. Specific assumptions and methodologies include:

1. That per capita consumption rates are based on an average of 124 gpcd. Future rates are expected to be 120 gpcd in the year 2000 and 125 gpcd in the year 2020. Initial decreases in consumption rates are attributed to improved construction techniques and reduction of infiltration/inflow.

TABLE 7-30
PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN THE RAPPAHANNOCK RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	TOTAL POPULATION	CPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Fredericksburg City*	—	1980	15,200	145	2.2	3,200
		2000	16,600	163	2.7	3,800
		2020	17,200	192	3.3	4,300
Caroline County	—	1980	1,574	109	0.17	315
		2000	1,879	118	0.22	430
		2020	2,437	146	0.36	610
Essex County	—	1980	7,700	95	0.73	1,540
		2000	9,400	121	1.14	2,162
		2020	11,600	151	1.75	2,900
King & Queen County	—	1980	783	—	—	157
		2000	769	125	0.10	177
		2020	798	154	0.12	199
King George County	—	1980	2,565	98	0.25	513
		2000	3,317	126	0.42	763
		2020	9,100	127	1.16	2,093
Lancaster County	—	1980	9,100	109	1.00	1,820
		2000	9,100	127	1.16	2,093
		2020	9,100	141	1.28	2,275
Middlesex County	—	1980	3,382	91	0.31	676
		2000	3,435	138	0.47	790
		2020	3,596	150	0.54	900
Northumberland County	—	1980	5,134	103	0.53	1,026
		2000	4,896	133	0.65	1,126
		2020	4,776	143	0.68	1,194
Richmond County	—	1980	6,700	87	0.58	1,340
		2000	7,300	111	0.81	1,679
		2020	7,900	157	1.24	1,975
Spetsylvania County	—	1980	10,195	98	1.00	2,039
		2000	14,920	124	1.85	3,432
		2020	20,340	149	3.03	5,085
Stafford County	—	1980	15,658	101	1.61	3,192
		2000	27,565	123	3.39	6,340
		2020	41,589	149	6.20	10,397
Westmoreland County	—	1980	1,977	100	0.20	395
		2000	2,319	120	0.28	533
		2020	2,676	150	0.40	669
	TOTALS			(Avg.)		(Avg.)
		1980	80,248	103	8.58	16,213 (1,351)
		2000	101,499	127	13.10	23,335 (1,943)
		2020	126,249	153	19.54	31,544 (2,633)

* Includes Industrial.

SOURCE: (13)

TABLE 7-31
PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN THE YORK RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	TOTAL POPULATION	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD5 LOADING (lbs/day)
Caroline County	--	1980	13,926	109	1.52	2,785
		2000	16,621	118	1.96	3,823
		2020	21,563	146	3.15	5,391
Gloucester County	--	1980	17,000	88	1.50	3,400
		2000	18,400	122	2.24	4,232
		2020	31,000	148	4.59	7,750
Goochland County	--	1980	633	100	0.06	127
		2000	1,308	121	0.16	301
		2020	2,385	149	0.35	596
Hanover County	--	1980	33,658	99	3.33	6,732
		2000	58,901			
		2020	87,750	149	13.07	21,938
James City County	--	1980	3,249	95	0.31	650
		2000	6,134	125	0.77	1,411
		2020	10,251	149	1.53	2,563
King & Queen County	--	1980	4,417	--	--	883
		2000	4,332	125	0.54	996
		2020	4,502	154	0.69	1,126
King William County	--	1980	7,500	105	0.79	1,500
		2000	7,800	128	1.00	1,794
		2020	8,200	148	1.21	2,050
New Kent County	--	1980	3,169	125	0.40	634
		2000	5,461	133	0.73	1,256
		2020	9,751	150	1.46	2,438
Spotsylvania County	--	1980	10,305	97	1.00	2,061
		2000	15,080	124	1.87	3,468
		2020	20,560	149	3.06	5,140
York County	--	1980	16,648	100	1.66	3,330
		2000	32,829	123	44.04	7,551
		2020	59,265	149	8.83	14,816
Mathews County	--	1980	7,200	--	--	1,440
		2000	7,400	136	1.00	1,702
		2020	7,700	154	1.19	1,925
Middlesex County	--	1980	2,918	105	0.31	584
		2000	2,965	138	0.41	682
		2020	3,104	150	0.47	776
				(Avg.)		Avg.
	TOTALS	1980	120,623	102	10.88	24,126 (2,010)
		2000	182,233	126	21.04	40,769 (3,397)
		2020	266,031	150	39.60	66,509 (5,542)

SOURCE: (18)

TABLE 7-32
PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN THE LOWER JAMES RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD$_5$ LOADING (lbs/day)
Richmond Planning District	Goochland/Henrico	2000	42,000	120	5.0	8,300
		2020	80,000	125	10.0	17,000
	City of Richmond	2000	540,000	120	65.0	110,000
		2020	560,000	125	70.0	120,000
	Falling Creek	2000	98,000	120	12.0	20,000
		2020	150,000	125	18.0	30,000
	Proctors Creek	2000	65,000	120	8.0	13,000
		2020				
	Henrico	2000	98,000	120	12.0	20,000
		2020	115,000	125	14.0	23,000
Crater Planning District	Johnson's Creek	2000	42,000	120	5.0	8,300
		2020	144,000	125	18.0	30,000
	City of Hopewell	2000	37,500	120	4.5	7,500
		2020	52,000	125	6.5	11,000
	City of Petersburg	2000	162,500	120	19.5	33,000
		2020	172,000	125	21.5	36,000
Peninsula Planning District	HRSD--Williamsburg	2000	100,000	120	12.0	20,000
		2020	160,000	125	20.0	33,000
	HRSD--James River	2000	110,000	120	13.0	22,000
		2020	160,000	125	20.0	33,000
	HRSD--Boat Harbor	2000	250,000	120	30.0	50,000
		2020	360,000	125	45.0	75,000
Southeastern Planning District	HRSD--Lambert's Point	2000	290,000	120	35.0	58,000
		2020	320,000	125	40.0	67,000
	HRSD--Army Base	2000	110,000	120	13.0	22,000
		2020	144,000	125	18.0	30,000
	HRSD--Chesapeake Elizabeth	2000	280,000	120	34.0	57,000
		2020	384,000	125	48.0	80,000
	City of Portsmouth	2000	115,000	120	14.0	23,000
		2020	120,000	125	15.0	25,000
	City of Suffolk	2000	75,000	120	9.0	15,000
		2020	96,000	125	12.0	20,000
	TOTALS			(Avg.)		(Avg.)
		2000	2,415,000	120	291.0	487,100 (30,444)
		2020	3,097,000	125	386.0	617,000 (38,563)

SOURCE: (21)

2. That projected raw or influent wasteloads are based on a typical wastewater concentration of 200 mg/l BOD. Multiplication of this concentration by the projected flow and a conversion factor of 8.34 yields the projected BOD loading in lbs/day.

STUDY AREA V–LOWER EASTERN SHORE

Accomack-Northampton Counties. Table 7-33 presents the projected municipal wastewater flows and influent or raw waste loadings for the populated service areas of Accomack and Northampton Counties for the years 1980 and 2000 as summarized from the Accomack-Northampton Planning District 303(e) Water Quality Management Plan (22). The projected loadings are based upon population figures and per capita use rates determined by land usages prepared by the Accomack-Northampton Planning District. Among the specific assumptions and methodologies are:

1. That per capita consumption rates are based on historical data and will be assumed to remain at or near 100 gpcd throughout the study period. Most of the rates presented in the table are not 100 gpcd, as the addition of industrial flows alters this number.

2. That projected raw or influent wasteloads are based on a typical wastewater concentration of 240 mg/l BOD. Multiplication of this concentration by the projected flow and a conversion factor of 8.34 yields the projected BOD loading in lbs/day.

Pocomoke River Area. Table 7-34 presents the projected municipal wastewater flows and discharge of effluent loadings for the Pocomoke River Area for the years 1980 and 2000 as summarized from the Pocomoke River 303(e) Water Quality Management Plan (30). The loadings are based on population figures and per capita flows agreed upon by the Maryland Water Resources Administration (WRA), the Maryland Department of State Planning (DSP), and local or county water-sewer authorities. Specific assumptions and methodologies include:

1. That gpcd rates are based on actual wastewater production rates and estimated amounts of infiltration/inflow. These figures have been assumed to increase slightly in the future and may include industrial inputs.

2. That projected effluent loadings are based on average effluent concentrations as monitored by the Maryland Department of Health and Mental Hygiene and valid discharge permit limitations developed through 1980 (20 mg/l).

Nanticoke River Area. The projected municipal wastewater flows and discharge or effluent loadings for the Nanticoke River Area for the years 1980 and 1995 as summarized from the Nanticoke River 303(e) Water

TABLE 7-33
PROJECTED SEWAGE FLOWS AND RAW WASTE LOADINGS IN THE ACCOMACK-NORTHAMPTON COUNTY AREA

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Accomack-Northampton Counties	Cape Charles	1980	1,600	100	.16	320
		2000	2,200	100	.22	440
	Exmore*	1980	1,400	122	.171	342
		2000	2,550	132	.336	673
	Parksley*	1980	1,360	169	.23	460
		2000	1,430	172	.246	492
	Onancock	1980	2,580	102	.264	528
		2000	3,030	108	.327	655
	Saxis*	–	–	–	–	–
		2000	400	125	0.05	100
	Tangier	1980	800	100	0.08	160
		2000	800	100	0.08	160
				(Avg.)		Avg.
	TOTALS	1980	7,740	–	0.905	1,810 (362)
		2000	10,410	–	1.259	2,520 (420)

*Includes industrial flows.

SOURCE: (22)

TABLE 7-34
PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE POCOMOKE RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Pocomoke River Mainstem	Snow Hill	1980	3,000	100	0.30	50
		2000	2,600	100	0.26	43
	Pocomoke City*	1980	4,200	222	0.9	150
		2000	4,100	222	0.9	150
Little Annemessex River	Crisfield	1980	6,500	150	.98	163
		2000	7,200	150	1.08	180
	Princess Anne	1980	3,500	125	0.45	75
		2000	4,000	150	0.60	100
Deal Island Area	Deal Island	1980	1,800	100	0.18	-
		2000	1,600	100	0.16	-
						Avg.
	TOTALS	1980	19,000	119	2.81	438 (110)
		2000	19,500	125	3.00	473 (118)

*Includes industrial input.

SOURCE: (30)

Quality Management Plan (31) are presented in Table 7-35. The loadings are based on population figures, sewage service areas, and per capita flows agreed upon by the Maryland Water Resources Administration, the Maryland Department of State Planning, and local or county water-sewer authorities. Among the specific assumptions and methodologies are:

1. That gpcd rates are based on actual wastewater production rates and estimated amounts of infiltration/inflow. Future rates have been assumed to increase slightly and represent the best available estimate by local authorities.

2. That projected effluent loadings are based on average effluent concentrations as monitored by the Maryland Department of Health and Mental Hygiene and valid discharge permit limitations developed through 1980.

STUDY AREA VI–UPPER EASTERN SHORE

Choptank River Basin. No Data.

Chester River Basin. No Data.

Elk River Basin. Table 7-36 presents the projected municipal wastewater flows and discharge or effluent loadings for the Elk River Basin for the years 1980 and 1995 as summarized from the Elk River 303(e) Water Quality Management Plan (32). The projected loadings are based upon population figures and per capita flow estimates agreed upon between the Maryland Water Resources Administration, the Maryland Department of State Planning, and the local and county water-sewer authorities. Among the specific assumptions are:

1. That gpcd rates are based on historical rates and will stay constant in the future. That is, no increases.

2. That excessive inflow/infiltration will be cut in half through conservation measures.

3. That future flows (gpcd) were determined by dividing 1/2 of the excess infiltration/inflow by the population served and adding to the existing gpcd.

4. That projected effluent loadings are based upon average effluent concentrations as monitored by the Maryland Department of Health and Mental Hygiene and valid discharge permits limitations developed through 1980.

TABLE 7-35
PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE NANTICOKE RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Marshyhope Creek	Federalsburg	1980	2,300	125	.29	72
		1995	2,600	125	.33	82
	Hurlock*	1980	1,100	1,523	1.4	82
		1995	1,400	1,300	1.8	105
Wicomico Headwaters	Delmar	1980	2,200	100	0.2	33
		1995	2,000	100	0.2	33
	Salisbury**	1980	17,700	270	4.8	800
		1995	19,400	270	5.2	867
	Fruitland	1980	2,800	90	.25	41
		1995	3,700	90	.33	55
	Salisbury Metro Core	1980	31,000	-	5.3	-
		1995	43,000	-	5.7	-
						Avg.
	TOTALS	1980	57,100	105	12.24	1,028 (206)
		1995	72,100	105	13.56	1,142 (228)

*Includes industrial flows.
**Represents outlying areas of Salisbury. Flow represents 3.0 mgd of industrial flow and 1.8 mgd of domestic flows for weekdays only. Industrial flows are not a factor on weekends.

SOURCE: (31)

TABLE 7-36
PROJECTED SEWAGE FLOWS AND DISCHARGE LOADINGS IN THE ELK RIVER BASIN

SEGMENT	SERVICE AREA (Treatment Plant)	TIME PERIOD	POPULATION SERVED	GPCD	PROJECTED FLOW (MGD)	PROJECTED BOD_5 LOADING (lbs/day)
Elk Mainstem	Chesapeake Coves*	1995	1,500	90	.135	33.7
Back Creek	Chesapeake City	1980	1,166	130	.152	38.0
		1995	1,420	130	.185	46.3
North East River	North East*	1980	5,722	93.5	.535	26.0
		1995	10,206	93.5	.954	62.6
Furnace Bay	Perryville*	1980	3,000	120	1.075	89.5
		1995	4,500	120	1.255	104.5
Elk River Headwaters	Elkton	1980	10,000	120	1.20	N.A.
		1995	16,000	120	1.92	N.A.
	Holly Hall	1980	4,000	90	.36	N.A.
		1995	6,000	90	.54	N.A.
				(Avg.)		Avg.
	TOTALS	1980	23,888	111	3.322	154 (51)
		1995	39,626	107	4.989	247 (62)

*Includes industrial flows.

SOURCE: (32)

INDUSTRIAL WASTEWATER FLOWS

Industrial discharges are also important and can have a great bearing on the achievement of water resource management goals in the future, especially in areas where industries concentrate. Most notable of these in the Bay Region are the Baltimore, Norfolk, and Hopewell Areas. Clearly a function and a by-product of the water supply and economic development, the projected industrial discharge flow rates to be presented in this section are based on the Economic Sub-areas shown in Figure 7-3 and data developed by the Burea of Domestic Commerce, U.S. Department of Commerce.

Two figures, one a simple projection of historical data, and the other which reflects improved recirculation technology are presented here. It is felt that the expected discharge will fall between the two values, however the curves reflecting improved technology will be more likely to occur as P.L. 92-500 standards and policies are more fully implemented.

Although more thoroughly discussed in Appendix 5: Municipal and Industrial Water Supply, the basic assumptions and methodology for the improved technology projections will be briefly discussed here. However, only the discharge flow rates and not the entire computational process will appear in this section.

Projected withdrawal requirements are calculated by assuming that improving recycling practices will occur as higher levels of waste treatment are instituted and required by the Federal Water Pollution Control Act Amendments of 1972. The specific assumptions with respect to the recycling rates are:

1. That "best available technology," required by 1985, is reflected in the average of the 20 highest recycling ratios reported by all individual industries in a 1970 Burea of Domestic Commerce Survey. After breakdown into a 2 digit Standard Industrial Classification Group (SIC), the assumption was made that these recycling ratios would be achieved by entire industrial groups, regionally and nationally, by 1985.

2. That for the year 2000, each industrial group will achieve maximum theoretically possible recycling ratios. The theoretical maximum recycling rate is calculated from current gross water uses and projected minimum intakes. Beyond the year 2000, recycling rates are kept constant.

From historically calculated gross water demands and recycling rates for 1985 and 2000, projected withdrawal requirements are then derived. For the interim years of 1980 and 1990, the withdrawal requirements are computed on recycling rates computed by compound interest rate formulate from the difference between 1980 and 1985, and 1985 and 2000, respectively. Projected consumptive uses are then based on a continuation of the observed

relationship of consumption to gross demand as revealed in the 1970 Bureau of Domestic Commerce survey, and converting that relationship to a national average for any particular industrial group.

The end product of this computation, for water quality purposes, is the projected volume of discharge to Chesapeake Bay waters. This is accomplished simply by subtracting the projected consumptive losses from the projected withdrawal rates determined earlier. While this projection does not specifically address actual concentrations of waste products or projected discharge loadings, it does however serve as an indicator of the marked decrease in industrial waste discharges that may be expected in pursual of national water quality goals.

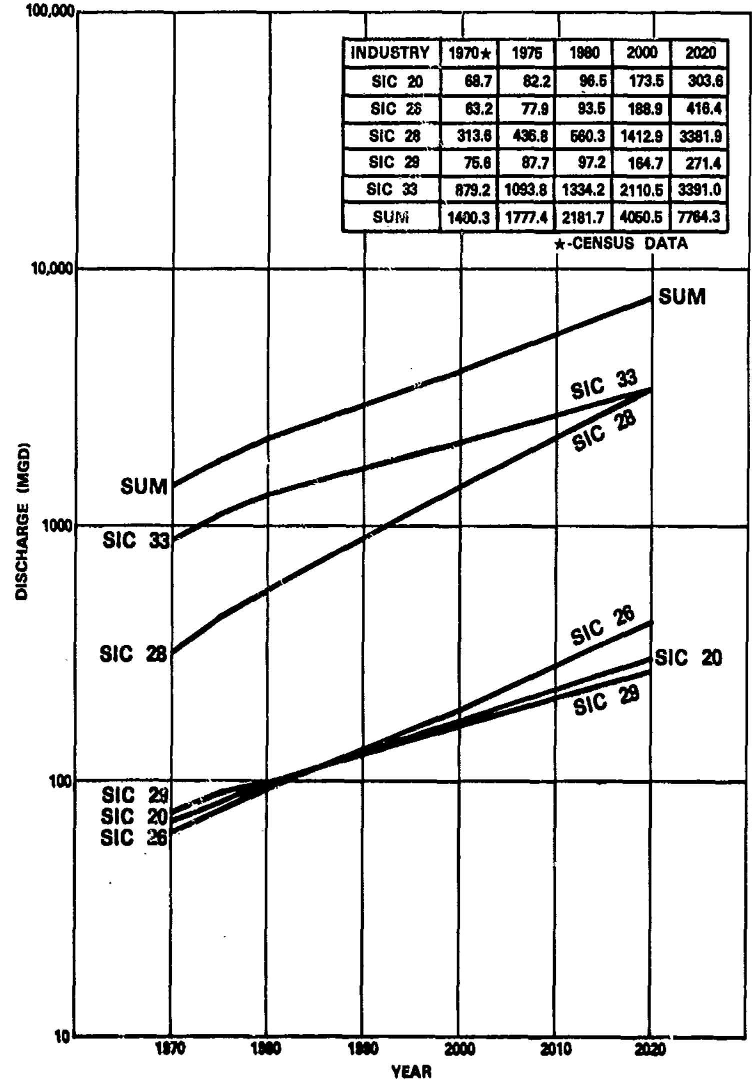
Figures 7-19 and 7-20 illustrate the projected industrial discharges, with and without technology, to Chesapeake Bay waters and its tributaries. These figures again are based on data developed by the Bureau of Domestic Commerce for the 5 major categories of industries in the Bay Region which discharge greater than 10 million gallons per year. According to the 1970 Bureau of Domestic Commerce Survey, approximately 82 percent of the total water withdrawals in the Chesapeake Bay Region are accounted for in Standard Industrial Classification (SIC) groups 26 (paper and allied products), 28 (chemicals), and 33 (Primary metals). The other major groups are SIC 20 (food and kindred products) and SIC 29 (petroleum). It should be noted that the "sum" in the figures represents only the addition of the five group totals and not all industries in the Bay Area. It does, however, account for approximately 99 percent of the expected total water demand.

NON-POINT SOURCES

The non-point sources of pollution can contribute large quantities of suspended sediments, bacteria, total and fecal coliform organisms, oxygen demanding substances (BOD), and nutrients including nitrogen and phosphorus. The most serious of the existing problems in the Chesapeake Bay Study Area, as discussed in Chapter II, are the suspended sediment loads and nutrients.

Future non-point loadings have not been presented in this section, primarily due to the lack of historical data and the extreme variability of the non-point parameters involved. Enforcement problems and the high cost of study programs have also stalled efforts to identify, solve, and project non-point source problems. This is not to say that non-points are not expected to be important in the future, because in some cases such as heavy agricultural areas, the non-point sources are expected to be the major contributors to water quality degradation.

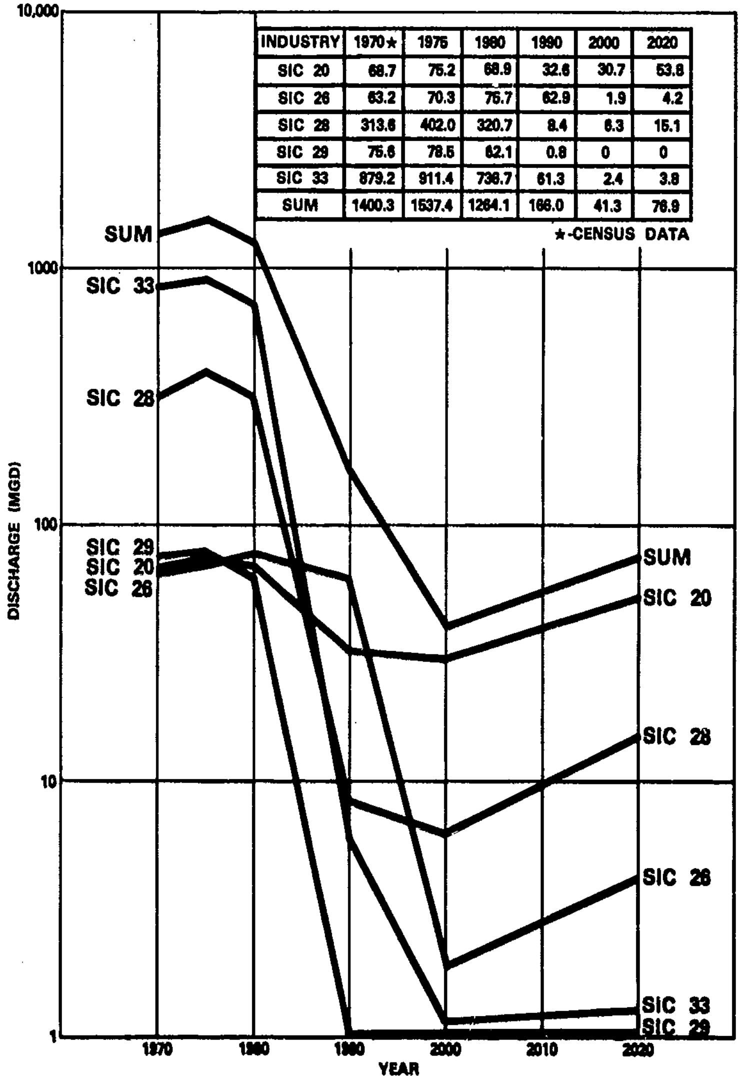
What can be said about future non-profit loads is that, based on current data developed, serious problems can be expected to occur if the additions of



INDUSTRY	1970★	1976	1980	2000	2020
SIC 20	68.7	82.2	96.5	173.5	303.6
SIC 26	63.2	77.9	93.5	188.9	416.4
SIC 28	313.6	436.8	560.3	1412.9	3381.9
SIC 29	75.6	87.7	97.2	164.7	271.4
SIC 33	879.2	1093.8	1334.2	2110.5	3391.0
SUM	1400.3	1777.4	2181.7	4050.5	7764.3

★-CENSUS DATA

Figure 7-19: Industrial Discharge Projections for Chesapeake Bay Without Technology (MGD)



INDUSTRY	1970★	1975	1980	1990	2000	2020
SIC 20	68.7	76.2	68.9	32.6	30.7	53.8
SIC 26	63.2	70.3	76.7	62.9	1.9	4.2
SIC 28	313.6	402.0	320.7	8.4	6.3	15.1
SIC 29	75.6	78.5	62.1	0.8	0	0
SIC 33	879.2	911.4	738.7	61.3	2.4	3.8
SUM	1400.3	1537.4	1264.1	166.0	41.3	76.9

★-CENSUS DATA

Figure 7-20: Industrial Discharge Projections for Chesapeake Bay With Technology (MGD)

sediment, sewer overflow, nutrients, vessel discharges, dredge spoil, pesticides, and heavy metals are allowed to continue without controls. Studies by the Smithsonian Institution (33) and the Interstate Commission on the Potomac River Basin (ICPRB) (34) have begun to set a data base. Acceptable procedures which may be used to determine projected non-point loads are being developed and additional information will become available for the Bay Area as Phase II of the Water Quality Studies required by Section 208 of the Federal Water Pollution Control Act Amendments of 1972 are initiated in the near future.

OBJECTIVES AND WATER QUALITY STANDARDS

P.L. 92-500 OBJECTIVES

The goals or objectives for water quality for both the present and foreseeable future are reflected in the goals and policy statements of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). Enacted on October 18, 1972, this law denotes the latest effort to clean up the waters of the United States and provide for enhancement and protection of territorial waters in the future. The overall objective of this Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." In order to obtain the objective of the Act, the following national goals were declared:

a. That the discharge of pollutants into navigable waters be eliminated by 1985;

b. That whenever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in or on the water be achieved by July 1, 1983.

c. That the discharge of toxic pollutants in the toxic amounts be prohibited.

d. That Federal financial assistance be provided to construct publicly owned waste treatment works.

e. That areawide waste treatment management planning processes be developed and implemented to assure adequate control of sources of pollutants in each state.

f. That major research and demonstration efforts be made to develop technology necessary to eliminate the discharge of pollutants into the navigable waters, waters of the contiguous zone, and the oceans.

WATER QUALITY STANDARDS

As a means to achieve the overall goals, sub-goals or water quality standards

have been developed. Among the different types of standards are: effluent standards, which set allowable limits for discharge of wastes from both municipal and industrial point sources; stream water quality standards, which set desired values for each water quality parameter in existing rivers and streams; toxic pollutant standards which limit the concentrations of toxic or lethal pollutants from point source discharges; oil and hazardous substance discharge standards, which prohibit the discharge of any quantities of oil or hazardous substances into or upon the navigable waters; marine sanitation discharge standards, which prevent the discharge of untreated or inadequately treated sewage into the waters; and thermal discharge standards, which may be imposed in addition to the effluent standards to limit the discharge of excessive volumes of heated waters. Perhaps the most important are the stream water quality standards, as their purpose is to protect the public health and welfare, enhance the quality of water in line with the uses to be made of a stream, and measure the progress of pollution control programs for both the present and future. Required initially by the Water Quality Act of 1965, the stream standards set acceptable levels for dissolved oxygen, pH, temperature, bacteria content, and turbidity. The enactment of P.L. 92-500 in 1972 required a revision of these standards, primarily to assure a more consistent method for evaluating water quality of the receiving waters on an interstate basis.

TABLE 7-37
DESIGNATED WATER USES IN THE STATE OF DELAWARE

Class	Water Use
A	Public Water Supply after reasonable treatment (nontidal portion only)
B	Industrial Water Supply after reasonable treatment
C	Primary Contact Recreation
D	Secondary Contact Recreation
E	Maintenance and propagation of fish and aquatic life and wildlife preservation
F	Maintenance and propagation of shellfish
G	Agricultural Water Supply
H	Navigation
I	Drainage
J	Passage of Anadromous Fish

TABLE 7-38
STREAM QUALITY CRITERIA FOR THE STATE OF DELAWARE

CLASS	STREAM QUALITY CRITERIA		
	Parameter	Unit	Criteria
All Nontidal Stream Basins	Temperature	°F	Nontidal Streams - Artificially induced rise shall not exceed 5°F above the normal for the section or 85°F, whichever is less.
	Dissolved Oxygen	mg/l	The dissolved oxygen levels shall not be less than a daily average of 5 mg/l nor go below 4 mg/l at any time except when natural phenomena cause this value to be depressed.
	pH	Unit	Shall be between 6.5 to 8.5.
	Fecal Coliform	Colonies/100 ml	The fecal coliform levels shall not exceed a log mean of 200/100 ml. Samples shall be taken at such frequency and location as to permit valid interpretation.
	Turbidity	Units	Not to exceed background by 10 units or a maximum of 25 units, whichever is less, except following precipitation.
All Tidal Stream Basins (except Delaware River and C & D Canal)	Temperature	°F	Coastal & Estuarine Waters - No heat may be added except in designated mixing zones which would cause temperature to exceed 85°F or which would cause the temperature to be raised by more than 4°F during September through May, or to be raised by more than 1.5°F during June through August. The rate of temperature change in designated mixing zones shall not cause mortality of fish or shellfish.
	Dissolved Oxygen	mg/l	Daily average concentration shall not be less than 6.0 mg/l nor less than 5.0 mg/l at any time except when natural phenomena cause this value to be depressed.
	pH	Units	Same as nontidal.
	Fecal Coliform	Colonies/100 ml	Same as nontidal.
	Turbidity	Units	Maximum monthly mean of 40 units maximum not to exceed 150 units.
C & D Canal (Delaware Portion only)	Temperature	°F	Same as tidal.
	Dissolved Oxygen	mg/l	During April 1 - June 15 and September 16 - December 31 seasonal average concentration shall not be less than 6.5 mg/l in the entire zone.
	pH	Units	Same as tidal and nontidal.
	Fecal Coliform	Colonies/100 ml	Same as tidal and nontidal.
	Turbidity	Units	Same as nontidal.

Source (33)

This section will present the most recent water quality stream standards for the States within the Chesapeake Bay Study Area to apply in the near and distant future. For each State, a series of 3 tables survey the stream water quality standards and criteria. The first table lists the intended and designated uses of all the waters within the State. The second table lists the acceptable values on special standards for each parameter and class of water use. The third and final table lists the various standards which apply to the segments of waters within the Chesapeake Bay Study Area.

TABLE 7-39
CLASSIFICATION OF DELAWARE WATERS WITHIN
THE CHESAPEAKE BAY AREA

SEGMENT	CLASSES	SPECIAL STANDARDS
Nanticoke River	B, G, D, E, H, I, C	Primary contact waters in lakes and ponds only. Agricultural Water Supply from non-tidal waters only. Navigation waters are only to head of tide.
Choptank River	C, D, E, G, I	Primary contact waters in lakes and ponds only.
Chesapeake Drainage (Chester & Elk Headwaters)	C, D, E, G, I	Primary contact waters in lakes and ponds only. Agricultural Water Supply from non-tidal waters only.

SOURCE: (35)

DELAWARE WATER QUALITY STANDARDS

Table 7-37, 7-38, and 7-39 inventory the stream water quality standards within the State of Delaware. These standards were prepared by the Delaware Department of Natural Resources, Division of Environmental Control and declared effective April 23, 1975. The following general criteria apply to all of the waters of the State at all times.

1. The waters shall not contain substances attributable to municipal, industrial, agricultural, or other discharges in concentrations or amounts sufficient to be adverse or harmful to water uses to be protected, or to human, animal, aquatic life and wildlife. The waters shall also be free from floating solids, sludge deposits, debris, oil, and scum.

2. Short transition zones shall exist between adjacent zones of varying water quality.

3. Water quality standards for certain portions of streams may be unattainable because of naturally occurring phenomena. In such instances, standards will be evaluated and modified as appropriate on a case by case basis.

4. Heat dissipation area--The limitations specified herein may be exceeded by special permit in heat dissipation areas designated by the Department on a case-by-case basis.

TABLE 7-40
DESIGNATED WATER USES IN THE STATE OF MARYLAND

CLASS	WATER USE
I	WATER CONTACT RECREATION & AQUATIC LIFE Waters which are suitable for water contact sports, play and leisure time activities where the human body may come in direct contact with the surface water, and the growth and propagation of fish (other than trout), other aquatic life, and wildlife.
II	SHELLFISH HARVESTING Waters where shellfish are propagated, stored, or gathered for marketing purposes, including actual or potential areas for the harvesting of oysters, softshell clams, hardshell clams, and brackish water clams.
III	NATURAL TROUT WATERS Waters which are suitable for the growth and propagation of trout, and which are capable of supporting natural trout populations and their associated food organisms.
IV	RECREATIONAL TROUT WATERS Waters which are capable of holding or supporting adult trout for put-and-take fishing, and which are managed as a special fishery by periodic stocking and seasonal catching.

Source: State of Maryland Water Quality Regulations 1974 (36)

Table 7-37 lists the designated uses of all the waters within the State of Delaware. Table 7-38 presents the stream quality criteria and Table 7-39 presents the classes of Delaware waters within the Chesapeake Bay Study Area.

MARYLAND WATER QUALITY STANDARDS

The stream water quality standards for the State of Maryland are inventoried in Tables 7-40, 7-41, and 7-42. These standards were prepared by the Maryland Department of Natural Resources and placed in effect on September 1, 1974. The following general criteria state that the waters of the State shall at all times be free from:

TABLE 7-41
STREAM QUALITY CRITERIA FOR THE STATE OF MARYLAND

CLASS	STREAM QUALITY CRITERIA		
	Parameter	Units	Criteria
I--Water Contact Recr. & Aquatic Life	Temperature	°F	Temperature elevations above natural shall be limited to 5°F, and the temperature may not exceed 90°F, outside of designated mixing zones.
	Dissolved Oxygen	mg/l	The dissolved oxygen concentration shall be not less than 4.0 mg/liter at any time, with a minimum daily average of not less than 5.0 mg/liter, except where, and to the extent that, lower values occur naturally.
	pH	Units	Normal pH values must not be less than 6.5 nor greater than 8.5.
	Fecal Coliform	Colonies/100 ml	If the fecal coliform density exceeds a log mean of 200/100 ml, the bacterial water quality shall be considered acceptable only if a detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters.
	Turbidity	Units	Turbidity in the receiving water resulting from any discharge may not exceed 50 JTU (Jackson Turbidity Units) as a monthly average, nor exceed 150 JTU at any time.
II--Shellfish Harvesting	Temperature	°F	Temperature elevations above natural shall be limited to 4°F in September through May, and to 1.5°F in June through August, outside of designated mixing zones.
	Dissolved Oxygen	mg/l	Same as Class I.
	pH	Units	Same as Class I.
	Fecal Coliform	Colonies/100 ml	The Most Probable Number (MPN) of fecal coliform organisms may not exceed 14/100 ml, as a median value and not more than 10 percent of the samples may exceed an MPN of 43/100 ml for a five-tube decimal dilution test (or 49/100 ml, where the three-tube decimal dilution test is used).
	Turbidity	Units	Same as Class I.
III--Natural Trout Waters	Temperature	°F	Temperature may not exceed 68°F beyond the distance from any point of discharge specified by the Administration, except where, and to the extent that, higher temperature values occur naturally.
	Dissolved Oxygen	mg/l	The dissolved oxygen concentration may be not less than 5.0 mg/liter at any time, with a minimum daily average of not less than 6.0 mg/liter, except where, and to the extent that, lower dissolved oxygen values occur naturally.
	pH	Units	Same as Class I.
	Fecal Coliform	Colonies/100 ml	Same as Class I.
	Turbidity	Units	Same as Class I.
IV--Recreational Trout Waters	Temperature	°F	Temperature may not exceed 75°F beyond the distance from any point of discharge specified by the Administration, except where, and to the extent that, higher temperature values occur naturally.
	Dissolved Oxygen	mg/l	Same as Class I.
	pH	Units	Same as Class I.
	Fecal Coliform	Colonies/100 ml	Same as Class I.
	Turbidity	Units	Same as Class I.

SOURCE: (34)

TABLE 7-42
CLASSIFICATION OF MARYLAND WATERS
WITHIN THE CHESAPEAKE BAY AREA*

Segment	Class	Unit Descriptions
Lower Susquehanna River Area		
- Deer Creek and all tributaries	III	Above Eden Mill Dam.
- Basin Run, Kellogg Branch, North Stirrup Run, South Stirrup Run, Deep Run	III	Mainstem Only.
- Deer Creek and all tributaries	IV	Below Eden Mill Dam, except those classified as natural trout waters.
- Octoraro Creek	IV	Mainstem Only.
Bush River Area		
- Bush River and tributaries Romney Creek, and Swan Creek	II	
- Bynum Run and all tributaries	III	
- Winters Run	IV	Above Atkisson Reservoir.
Gunpowder River Area		
- Gunpower River & tributaries	II	Above line from Oliver Point to Maxwell Point.
- Middle River	II	Above line from Log Point to Turkey Point.
- Little Gunpowder Falls and all tributaries	III	Above Jarrettsville Pike.
- Sawmill Branch, Gunpower Falls tributaries	III	Above and including Loch Raven Reservoir & tributaries.
- Cunpowder Falls	III	Mainstem only-above Prettyboy Reservoir.
- Little Gunpowder Falls	IV	Mainstem only-below Jarrettsville Pike.
- Gunpowder Falls	IV	Mainstem only-between Loch Raven and Prettyboy Reservoirs.
Patapsco River Area		
- Granite Branch, Mordella Br.	III	Mainstem Only.
- Jones Falls & all tributaries	III	Above Lake Roland.
- Morgan Run, Norris Run, Cooks Run	III	
- Red Run and all tributaries	III	Above Dolfield Road.
- Keysers Run	III	
- North Branch Patapsco River	IV	Mainstem only above Liberty Reservoir.

TABLE 7-42 (Continued)

Segment	Class	Unit Description
- South Branch, West Branch, East Branch Patapsco, Beaver Run	IV	Mainstem Only.
West Chesapeake Bay Area		
- Magothy River & tributaries	II	Above Henderson Point
- Severn River and tributaries	II	Above Mouth of Forked Creek
- South River & tributaries	II	Above Porter Point
- Rockhold Creek & tributaries	II	Above Masons Beach Road
- Tracys Creek	II	Above Route #256
- Severn Run & tributaries	II	Above Route #3
Patuxent River Area		
- All estuarine portions of tributaries, except:	II	
Patuxent River & tributaries		Above Ferry Landing
- Patuxent River & tributaries	IV	Above Rocky Gorge Reservoir
Lower Potomac River Area		
- All estuarine portions of tributaries, except:		
Potomac River & tributaries	II	Above Line from Smith Point to Simms Point
Washington Metropolitan Area		
- Paint Branch & all tributaries	III	Above Capital Beltway, I-495
- Little Seneca Creek & all tributaries	IV	Entire Little Seneca Creek Watershed.
- Rock Creek & all tributaries	IV	Above Route #28
Pocomoke River Area		
- All estuarine portions of tributaries, except:	II	
Manokin River & tributaries	II	Above Route #363
Big Annemessex River & tributaries	II	Above River Road
Jenkins Creek	II	Above mouth
Fair Island Canal	II	
Nanticoke River Area		
- Blackwater River & tributaries, Transquaking River & tribs, Monie Creek	II	Above mouth
- Nanticoke River & tributaries	II	Above line from Runaway Point to Long Point
- Wicomico River & tributaries	II	Above ferry crossing at White Haven.

TABLE 7-42 (Continued)

Segment	Class	Unit Description
Choptank River Area		
- Choptank River & tributaries	II	Above line from Bow Knee Point to Wright Wharf
- Tred Avon River & tributaries	II	Above Easton Point
Chester River Area		
- Chester River & tributaries	II	Above Route #213
- Corsica River	II	Above Earl Cove
- Piney Creek	II	Above Route #50
- Winchester Creek, St. Michaels Harbor	II	Above Mouth
Elk River Area		
- Elk River & tributaries	II	Above line from Bull Minnor Point to Courthouse Point.
- Bohemia River & tributaries	II	Above line from Rich Point to Blatery Point
- Sassafras River & tributaries	II	Above Ordinary Point
- Stillpond Creek & tributaries	II	Above Kinnaird Point
- Worton Creek, Fairlee Creek, Northeast River	II	Above mouth
- Principio Creek & tributaries	III	
Chesapeake Bay (Proper)		
- All waters of the Chesapeake Bay Proper	II	From Susquehanna River mouth to Virginia line, includes (a) the tidal waters of the Chesapeake Bay bounded generally by the shorelines to the Bay and by "zero river mile" lines of estuaries and tributaries to the Bay, as designated by the Water Resources Administration; and (b) any peripheral waters designated as part of the Chesapeake Bay Proper by the Water Resources Administration, after consultation with the Maryland Fisheries Administration.

*NOTE: All waters of the State chall be protected for use as water contact recreation, for fish, other aquatic life, and wildlife (Class I)

(SOURCE--36)

1. Substances attributable to sewage, industrial waste, or other waste that will settle to form sludge deposits that are unsightly, putrescent or odorous to such degree as to create a nuisance, or that interfere directly or indirectly with water uses;

2. Floating debris, oil, grease, scum, and other floating materials attributable to sewage, industrial waste, or other waste in amounts sufficient to be unsightly to such a degree as to create a nuisance or that interfere directly or indirectly with water uses;

3. Materials attributable to sewage, industrial waste, or other waste which produce taste, odor, or change the existing color or other physical and chemical conditions in the receiving waters to such a degree as to create a nuisance, or that interfere directly or indirectly with water uses; and

4. High-temperature, toxic, corrosive or other deleterious substances attributable to sewage, industrial waste, or other waste in concentrations or combinations which interfere directly or indirectly with water uses, or which are harmful to human, animal, plant, or aquatic life.

Table 7-40 lists the designated uses of all the waters within the State of Maryland. Table 7-41 presents the stream quality criteria and Table 7-42 presents the classes of Maryland waters within the Chesapeake Bay Study Area.

VIRGINIA WATER QUALITY STANDARDS

Tables 7-43, 7-44, and 7-45 inventory the stream, water quality standards for the Commonwealth of Virginia. These standards were prepared by the Virginia State Water Control Board pursuant to the Federal Water Quality Act of 1965 and amended in November 1974. The following general criteria are to apply to the waters of the State:

a. All State waters shall be maintained at such quality as will permit all reasonable, beneficial uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonable be expected to inhabit them.

b. All State waters shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with reasonable, beneficial uses of such water.

c. Zones for mixing wastes with receiving waters shall be determined on a case-by-case basis; shall be kept as small as practical in area and length; shall not be used for, or considered as, a substitute for waste treatment; and shall be implemented, to the greatest extent practicable, in accordance with the provisions of the above sections.

TABLE 7-43

DESIGNATED WATER USES IN THE COMMONWEALTH OF VIRGINIA

CLASS	WATER USE
I	OPEN-OCEAN (Seaside of the land mass).
II	ESTUARINE (Tidal water--Coastal Zone to fall line).
III	FREE-FLOWING STREAMS (Coastal Zone and Piedmont. Zone to the crest of the Mountains).
IV	MOUNTAINOUS ZONE
V	PUT AND TAKE TROUT WATERS
VI	NATURAL TROUT WATERS

Source: Virginia Water Quality Standards, November 1974 (37)

d. Stream standards will apply whenever flows are equal to, or greater than, the minimum mean 7-consecutive day drought flow with a 10-year return frequency.

e. Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at high quality; provided that the Board has the power to authorize any project or development, which would constitute a new or an increased discharge of effluent to high quality water, when it has been affirmatively demonstrated that a change is justifiable to provide necessary economic or social development; and provided, further, that the necessary degree of waste treatment to maintain high water quality will be required where physically and economically feasible. Present and anticipated use of such waters will be preserved and protected.

f. All waters within this State will be satisfactory for fishing and secondary contact recreation.

Table 7-43 lists the designated uses of all the waters within the Commonwealth of Virginia. Table 7-44 presents the stream quality criteria and Table 7-45 presents the classes of Virginia waters within the Chesapeake Bay Study Area.

TABLE 7-44
STREAM QUALITY CRITERIA FOR THE COMMONWEALTH OF VIRGINIA

Class	STREAM QUALITY CRITERIA Parameter	Unit	Criteria
I-Open Ocean	Temperature	°F	4.0 degrees above normal* (Sept-May) 1.5 degrees above normal (June-Aug) 2.0 degrees maximum hourly change**
	Dissolved Oxygen	mg/l	5.0 minimum
	pH	Units	6.0 - 8.5
II-Estuarine	Temperature	°F	4.0 degrees above normal* (Sept-May) 1.5 degrees above normal (June-Aug) 2.0 degrees maximum hourly change**
	Dissolved Oxygen	mg/l	4.0 minimum (5.0 daily average)
	pH	Units	6.0 - 8.5
III-Free Flowing Streams	Temperature	°F	5.0 degrees above normal* (90° maximum) 2.0 degrees maximum hourly change**
	Dissolved Oxygen	mg/l	4.0 minimum (5.0 daily average)
	pH	Units	6.0-8.5
IV-Mountainous Zone	Temperature	°F	5.0 degrees above normal* (87° maximum) 2.0 degrees maximum hourly change**
	Dissolved Oxygen	mg/l	4.0 minimum (5.0 daily average)
	pH	Units	6.0 - 8.5
V-Put and Take Trout Waters	Temperature	°F	5.0 degrees*** (70° maximum) 2.0 degrees maximum hourly change**
	Dissolved Oxygen	mg/l	5.0 minimum (6.0 daily average)
	pH	Units	6.0 - 8.5
VI-Natural Trout Waters	Temperature	°F	5.0 degrees*** (68° maximum) 2.0 degrees maximum hourly change**
	Dissolved Oxygen	mg/l	6.0 minimum (7.0 daily average)
	pH	Units	6.0 - 8.5
Subclass A - Secondary Contact Recreation	Coliform Organisms	colonies/ 100 ml	Fecal coliforms (multiple-tube fermentation or MF count) not to exceed a log mean of 1000/100 ml. Not to equal or exceed 2000/100 ml in more than 10% of samples. Monthly average value not more than 1000/100 ml (MPN or MF count). Nor more than 5000 MPN/100 ml in more than 20% of samples in any month. Not more than 20,000/100 ml in more than 5% of such samples.

TABLE 7-44 (Continued)

Class	Parameter	Units	Criteria
Subclass B - Primary Contact Recreation	Coliform Organisms	Colonies/ 100 ml	Fecal coliforms (multiple-tube fermentation or MF count) within a 30 day period not to exceed a log mean of 200/100 ml. Not more than 10% of samples within a 30-day period will exceed 400/100 ml. Monthly average not more than 2400/100 ml. (MPN or MF count). Not more than 2,400/100 ml in more than 20% of samples in any month. Not applicable during, nor immediately following periods of rainfall.
Shellfish Supplement	Fecal Coliform Organisms	Colonies/ 100 ml	The fecal coliform median MPN shall not exceed 14/100 ml; and not more than 10% of the samples oridinarily shall exceed an MPN of 43/100 ml for a 5-tube decimal dilution test (or 49/100 ml), where a 3-tube decimal dilution is used) in those portions of the area most probably exposed to fecal contamination during the most unfavorable conditions. Not to be so contaminated by radionuclides, pesticides, herbicides, or fecal material so that consumption of the shellfish might be hazardous.

*Natural temperature is that temperature of a body of water due solely to natural conditions without any influence from point source discharges.
**Maximum hourly temperature change of 2°F is to apply beyond boundaries of mixing zones and does not apply to natural conditions.
***Any rise above natural temperature to be allowed by Virginia State Water Control Board shall be determined on a case-by-case basis, but shall not exceed 5°F.

SOURCE (37)

TABLE 7-45
CLASSIFICATION OF VIRGINIA WATERS WITHIN THE CHESAPEAKE BAY STUDY AREA

Segment	Class	Special Standards*
POTOMAC RIVER BASIN		
- Tidal tributaries of the Potomac River including Upper Machodoc & Aquia Creeks	IIB	a, J, K, Public Water Supply
- Free flowing tributaries of the Potomac River including Potomac, Chopawamsic, Occoquan, Goose, Tuscarora, and Syncoline Creeks, and Broad, Difficult, and Sugarland Runs	IIIB	b, c, e, g. Public Water Supply
- Free flowing tributaries of the Potomac River including Aquia & North Fork Catoctin Creeks	IIIA	b, D, Public Water Supply
- Big Spring Creek and its tributaries in Loudoun County	VIA	-

TABLE 7-45 (Continued)

Segment	Class	Special Standards*
LOWER JAMES RIVER BASIN		
- Tidal portions of the James River and its tidal tributaries including the South and East Branch Elizabeth Rivers, Nansemond, Chickahominy, and Appomattox Rivers	IIB	a, J, K, Public Water Supply
- Free flowing portions of the James River and its freshwater tributaries including the East, West, and South Branches of the Elizabeth River, Pagan, Chickahominy, and Appomattox Rivers, Lake Prince and Lake Burnt Mills, Shingle, Diascund, Old Town, Swift, Powhattan, and Tuckahoe Creeks, and Chisel Run	IIIB	i, J, K, M, N, O, Public Water Supply
- Chickahominy and Appomattox Rivers, Swift Falling and Buffalo Creeks, and the Sandy River Reservoir	IIIA	m, Public Water Supply
RAPPAHANNOCK RIVER BASIN		
- Tidal portions of the Rappahannock River and its tributaries from Windmill Point to Route #1 bridge @ Fredericksburg	IIB	a
- Hoskins Creek	IIA	
- Free flowing portions of the Rappahannock River from Route #1 bridge to headwaters and its tributaries including Massaponas Creek, the VEPCO Canal, and Motts, Horsepen, Hunting, Wilderness, and Deep Runs	IIIB	q, Public Water Supply
- Free flowing portions of the Rappahannock from Blandfield Point to headwaters unless otherwise designated	IIIA	q
YORK RIVER BASIN		
- Tidal portions of the York River including Mattaponi & Pamunkey Rivers	IIB	a

TABLE 7-45 (Continued)

Segment	Class	Special Standards*
- Freeflowing portions of the York River and its tributaries, including Mattaponi, South Anna, and Pamunkey Rivers, Queens Creek, and Wallers Mill Pond	IIIB	Public Water Supply
- Free flowing portions of the Mattaponi River above Clifton, the Pamunkey River above Romancoke, the North and South Anna Rivers and Northeast Creek	IIIA	Public Water Supply
CHESAPEAKE BAY (PROPER)		
- Bay waters and its tidal tributaries from VA-MD state line to and along the Chesapeake Bay Bridge-Tunnel, and the tidal portions of the Lynnhaven Bay complex.	IIB	a, J, K
- Free flowing portions of Chesapeake Bay tributaries on the Eastern and Western Shore of Virginia	IIIB	e, j, k

*Special Standards define limitations other than those specified by the particular class and/or subclass. Detailed descriptions of each limitation can be found in the Virginia State Water Quality Regulations, as only an identifying title is reproduced here.

a. Shellfish Supplement
b. Potomac River Embayment Standards for Section from Hunting Creek to Route 301 Bridge
c. Effluent Standards for Williams and Upper Machodoc Creeks
d. Aquia Creek Discharge Proceedings
e. Temperature Standards for Lakes and Impoundments
f. Potomac Enforcement Conference Recommendations
g. Occoquan Watershed Policy
i. Powhattan Creek Watershed Policy
j. Nutrient Objectives
k. Chesapeake-Elizabeth Watershed Policy
m. Chickahominy Watershed Policy above Walker Dam
n. James River Discharge Policy
o. Tuckahoe Creek Discharge Policy
q. Rappahannock River Basin Effluent Standards Above Proposed Salem Church Dam

SOURCE: (37)

FUTURE WATER QUALITY PROBLEM AREAS

Based on the projected increases in wastewater loadings presented earlier in this chapter, the existing problem areas covered in Chapter II, and the water quality goals presented in the previous section, it is quite evident that enhancement and maintenance of the quality of the waters of Chesapeake Bay is a major challenge for the future. The solution to these problems will invariably become more complex as continuing research reveals information concerning the growing types and sources of water pollution. Also, as the point source problems come under the control of pollution abatement and discharge elimination plans, the focus of attention will shift toward non-point and management problems creating new and relatively unexplored difficulties. In this section, the potential problems of Chesapeake Bay waters will be surveyed by categorizing them on a basis of point and non-point sources, as well as management and other related areas.

POINT SOURCE PROBLEM AREAS

A rational statement with respect to the point related sources of pollution is that the existing problem areas, caused by municipal and industrial discharges, will not be corrected without an immense devotion of resources. This is basically due to the expected continuation of population growth and concentration of industry in areas already plagued by water quality problems. No new critical areas are expected to develop, as current abatement plans and the main focus of attention at this time are centered on the control of these sources. Nevertheless, ongoing and future problems can still be anticipated. The following paragraphs will identify the expected major point source problem areas of the waters in the Chesapeake Bay Region.

MUNICIPAL WASTEWATER TREATMENT NEEDS

An expectant problem with municipal wastewater treatment plants of the Chesapeake Bay Region is the need for increased capacities and treatment efficiencies as growing populations place heavier loads on existing systems. In Table 7-46, a comparison of the existing (1975) sewage treatment plant capacities to the projections for the years listed, demonstrates the capacity that will probably be needed to satisfy the demand for adequate wastewater disposal. It should be noted that the highest deficits occur in areas of high population concentration and where several problems already exist. In addition, higher BOD and nutrient removal efficiencies will be necessary before any improvement can be expected, especially in degraded areas. Many of the older treatment plants will not be capable of accomplishing this and must be rehabilitated or replaced. New facilities will be more sophisticated and expensive. All of this will require a tremendous investment in finances and resources.

TABLE 7-46
FUTURE MUNICIPAL WASTEWATER TREATMENT NEEDS

River Basin	Projected Flow Year	Projected Flow (mgd)	Existing Capacity (mgd, 1975)	Deficit (mgd)
Lower Susquehanna	1995	3.27	1.87	1.40
Patapsco	1990	261.60	238.76	22.84
West Chesapeake	2000	32.80	19.40	13.40
Patuxent	2000	96.30	39.40	56.90
Washington Metro.	2000	543.80	344.64	199.16
Northern Virginia	2020	363.30	111.98	251.32
Rappahannock	2020	19.54[1]	8.38	11.16
York	2020	39.60[1]	2.98	36.62
Lower James	2020	386.00	163.97	222.03
Accomack-Northampton	2000	1.26	.74	0.52
Pocomoke	2000	3.00	2.65	0.35
Nanticoke	1995	13.56	12.80	0.76
Elk	1995	4.99	3.40	1.59

[1]Based on total population and not population served.

THERMAL DISCHARGES

Increases in demand for electric power, outlined in Appendix 13, "Electric Power," will create the additional problem of disposal of heated cooling waters. In 1972, an average of nearly 7,700 mgd was discharged into Chesapeake Bay waters, almost 8.5 times the average discharge of sewage treatment plants in the area. Projected withdrawals for 1980 are expected to be near 8,500 mgd, of which 3,500 are required for the Surry and Calvert Cliffs Nuclear Power Plants.

The major concern is the effect such heavy concentrations of heated waters will have on the aquatic environment. Complicating the problem are the physical characteristics of Chesapeake Bay, an estuary which is relatively shallow and of moderate temperature, thereby limiting its efficiency for the dispersion of heated products. An additional problem, characteristic of nuclear power plants, is the potential escape of radioactive wastes into the waterways.

CHLORINE

Chlorine is used widely as a fouling preventative in industry and a disinfectant for municipal and industrial wastes. Until very recently, it was believed that its discharge into the waters of the Bay had very little effect on the biota. It has been discovered, however, that the free chlorine residuals which combine with elements in the water to form chloramines are not only harmful to aquatic life, but possible carcinogens. In fact, it has been found that the combination of free chlorine and chloramines (measured as total chlorine residuals) has caused up to a 90 percent reduction in primary productivity near wastewater treatment plant discharges. Future threats center around an overabundance of total chlorine residuals, due basically to the increased volumes of both municipal and industrial discharges as well as the required lowering of coliform densities in discharges which require increasing amounts of disinfection.

INFILTRATION/INFLOW (I/I)

Infiltration/inflow or the amount of water entering a sewerage system through sources such as defective pipes and stormwater runoff, has traditionally caused problems of overloading in both wastewater collection systems and treatment plants often resulting in the discharge of untreated wastes to the waterways. This is a particularly difficult problem to correct, especially in communities which have old, deteriorated systems or systems which carry both sanitary sewage and storm drainage (combined systems).

TOXIC MATERIALS

There are basically two types of toxic materials which are particularly troublesome in Chesapeake Bay—heavy metals and control agents such as insecticides, herbicides, and pesticides. Most of these substances are rather persistent (have a long life), are absorbed in the bottom sediments, and are often concentrated by aquatic organisms in their tissues. This latter phenomenon is of particular concern, as not only are the organisms themselves often destroyed, but there can be a synergistic effect in the food chain as higher levels of life feed on lower ones.

Although heavy metals such as mercury, lead, cadmium, and copper are often found in the natural environment, significant levels of these substances are usually associated with industrial discharges. Consequently, unacceptable concentrations of heavy metals are normally found near major manufacturing centers such as Baltimore, Maryland, and Norfolk, Virginia. Also, trace concentrations are often contributed by municipal wastewater treatment plants (38). As population and industrial activity grow, the problems of coping with heavy metal pollutions are expected to magnify.

Control agents such as arsenic, DDT, aldrin, mirex, and kepone originate in many places. The magnitude of their impact on both the aquatic

environment and residents of the area is very high, as evidenced by the serious problems currently occuring with kepone in the James River basin. The chemicals themselves may be damaging in small doses and minute concentrations can usually be found in the wastewater effluents of the plants which manufacture them, in the runoff from areas where they are stored, in the runoff from urban areas and agricultural lands where they have been applied, and in the effluents of nearly every type of wastewater treatment plant. Because of this, these agents are very difficult to control and it appears at this time that the only solutions are to severely limit their use or to find substitutes which are either less lethal or less persistent.

FINANCIAL CAPABILITIES

The adequacy of existing technology to meet goals and objectives of future water pollution programs does not appear to be a significant problem. The costs associated with implementing these improvements, however, appears to be a problem of great magnitude. In a 1973 report by the National Water Commission to the President of the United States (39), it was estimated that implementation of pollution abatement policy based on "Best Available" technology for treatment of both municipal and industrial point source wastes by 1983 would require expenditures of about $460 billion through 1983. Implementation of a true "no discharge" policy had been estimated to cost several times that amount.

The overlying and perhaps the most significant point source problem is, therefore, the choices that must be made between spending the enormous

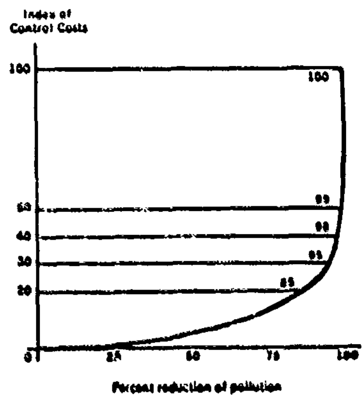


Figure 7-21: Total Control Costs as a Function of Effluent Control Levels

Source: U.S. ENVIRONMENTAL PROTECTION AGENCY (1972). The Economics of Clean Water, Vol. I. U.S. Government Printing Office, Washington, D.C. p. 151.

amounts of money to achieve "no discharge" goal and the sacrifices society would have to make in other social areas such as housing, education, highways, medical care, full employment, and economic price stability. Figure 7-21, prepared by EPA, shows how the costs increase as levels of treatment increase. As indicated, a clean-up of the last 1 percent of pollution involves a doubling of the already large costs involved in eliminating the first 99 percent.

NON-POINT SOURCE PROBLEM AREAS

Non-point source problems, especially in the rural areas of the Bay Region, are very important and play a large role in the degradation of area waters. As clean up of the point source wastes progresses, the impact of non-point pollution will become more apparent.

The methods for controlling non-point sources are currently in a more primitive or undeveloped stage than those of point sources, and a great deal of research and effort is required before major improvements can be expected. It is for this reason that the problems discussed in the following paragraphs present the greatest future challenge.

AGRICULTURAL RUNOFF

With approximately 40 percent of the Bay's land area in agricultural use, pollutants such as nutrients, pesticides, sediment, and animal waste products can be expected to contribute a significant loading, especially during heavy periods of rain. Although the percentage of land in agricultural use is projected to decrease, intensive farming practices which attempt to grow the same or greater amounts of crops on smaller land areas may contribute even greater loadings than before.

URBAN RUNOFF

Urban runoff, as opposed to agricultural, may be expected to increase markedly as population growth and urban expansion continues. Large amounts of runoff containing oils, chemicals, and sediments are already causing problems near the major cities of the Chesapeake Bay Region. Currently, the technology for capturing, channelizing, and treating these wastes before they enter the waterways is not entirely cost effective and they will continue to be a problem until such methods are made available.

SEDIMENTATION

Sediment, a natural phenomenon which is added greatly to by man's activities, will continue to plague the large rivers and main ports of the Chesapeake Bay Region. In those areas where sediment concentrations currently exist in excess quantities such as the Washington Metropolitan

Area and at the mouth of the Susquehanna River, large sums of money have been expended to maintain navigable channels and to control runoff of sediment from both urban and rural sources. In addition, damages to the ecology of the rivers and Bay by the inhibition of light and the resulting destruction of benthic organisms has also caused some problems and is expected to continue in the future.

OIL AND MARINE TRANSPORTATION SPILLS

With the projected increase in both the size of ships and the total amount of oil products shipped on Chesapeake Bay, the probability of accidental spills both in transit and near the unloading facilities will also increase. Other hazardous chemicals in transport will also be subject to accidental spills as Bay traffic increases.

Other potentially large sources of oil include municipal waste discharges, industrial waste discharges, and urban runoff. These sources, especially municipal discharges, have not yet been thoroughly researched, and more detailed information on these subjects can be found in Appendix 15, "Biota."

RECREATIONAL AND COMMERCIAL BOATING

The large populations of both commercial vessels on the intercoastal waterways and pleasure crafts concentrated near the many marinas of Chesapeake Bay currently contribute a significant amount of raw sewage through direct overboard discharges. The problems caused by these discharges are expected to continue into the future until adequate pumping facilities can be installed to treat the sewage at marina and port facilities.

DREDGED MATERIAL DISPOSAL

The disposal of dredged material from navigable channels filled in by sedimentation is expected to continue to be a perplexing problem. Suitable, environmentally safe disposal areas appear to be at a premium, but other methods of either using or disposing of the material have yet to be found. This problem is, and will continue to be, especially critical in the Baltimore and Hampton Roads areas where maintenance dredging and channel deepening projects are necessary for the economic survival of the ports. Again, these projects will require rather large but suitable areas for the disposal of potentially highly toxic sediments. The Hart-Miller Islands project in Baltimore and the Craney Island projects in the Hampton Roads area are matters which will have to be solved and may be of prime concern in the near future. An added problem with the dredging process itself is that the deepening of channel bottoms undoubtedly disturbs the sediment, possibly releasing to the aquatic environment those toxic substances which have settled out of the watercourse many years prior.

SEPTIC SYSTEM FAILURES

Failing septic systems, which cause major problems in the rural areas of Chesapeake Bay can be expected to continue to plague those areas until either the old systems are repaired or sewer service can be provided. In those areas outside of expected sewerage expansions and where poor soil conditions exist, new methods of handling wastes from individual homesites will have to be found before improvement can be expected.

SOLID WASTE LEACHATE

Seepage from the ever increasing number of solid waste dumps and sanitary landfill sites may also pose a serious threat to water quality, especially in the contamination of groundwater supplies. Protection of both private and public water supplies by sealing them off from the potentially high amounts of sodium, potassium, calcium, magnesium, and organic pollutants characteristic of this leachate will be necessary to avoid contamination problems in the future. Also, some means of treating the collected leachate will be necessary.

MANAGEMENT AND OTHER PROBLEM AREAS

The previous sub-sections discussed the major point and nonpoint sources of pollution in the Chesapeake Bay Region. It must be recognized, however, that workable management structures are required if any progress is to be realized in correcting problem areas, both now and in the future. Various organizational and management difficulties within the State, interstate, and Federal management agencies of the Chesapeake Bay Region can reasonably be expected in the future. This is mainly because most of the existing systems are organized differently and may not be structured to handle some of the existing or expected problem areas. In the following paragraphs, these management problems along with those problems which could not clearly be classified as definitely point or nonpoint source problems, shall be covered in an attempt to conclude the survey of the major water quality problems expected for the Chesapeake Bay Area.

MANAGEMENT PROBLEMS

In pursuing the goals of improved water quality, numerous problems can be and are encountered by the responsible management agencies. These problems vary widely and are dependent mostly upon the size of surrounding populations, topography, climate, natural drainage, political boundaries, and other factors. The problems which currently occur most often and may be expected to continue to cause management problems in the near future are:

1. The inability to finance wastewater collection and treatment facilities.

2. The intrusion of urbanized areas into rural watersheds and the resulting deterioration of water quality.

3. The poor integration of water supply, wastewater treatment, and disposal services.

4. Poor land use planning which may permit additional development in areas currently suffering from water quality degradation.

5. Inadequate institutions for managing metropolitan water services and for representing metropolitan viewpoints in Federal, State, local, and interstate water resource management.

6. Lack of proper attention in providing metropolitan water services including neglect of recreational, esthetic, and environmental values.

7. The conflicts of economic, social, and environmental issues with the correction of water quality problem areas.

8. Lack of effective citizen education and public participation programs.

9. Duplication and overlapping of various services and goals of Federal, State, and local government agencies.

MANPOWER

The need for well-trained personnel to operate wastewater treatment plants is important, as the ability of a treatment facility to achieve design efficiency is primarily dependent upon the skill and knowledge of the operator. The expected expansion of wastewater treatment plants in the future will require an increasing number of personnel technically competent and adequately trained to operate the increasingly complex facilities. In addition, there will be a need to improve the skills of present personnel through in-service training.

Additional efforts will also be necessary to provide adequately trained manpower to efficiently administer water pollution control programs. It will also be necessary that salaries in the field be competitive enough to attract an adequate and qualified work force.

LACK OF DATA BASE

Basic data on water related matters provides a basis for planning, decision making, and evaluation. An existing and projected need is for

expanded monitoring of trends in water quality to improve selection of effective management measures and for enforcement purposes. Equally important is the critical need for assurance that all potential users know what type of data are available so that they can obtain it when needed. The underlying problem, however, is achieving and maintaining relevant data for Chesapeake Bay which will meet the changing needs of its users.

ENFORCEMENT

Due to the broad scope and many unexpected facets of water quality management, enforcement of water quality programs such as overboard discharge policies, stream water quality standards, effluent guidelines, and discharge permits have been somewhat troublesome. Complicated by the lack of large work forces, adequate treatment facilities to accomodate the implementation of control programs, and clear definition of ultimate authority and responsibility under existing laws, problems have developed and will continue to hamper water quality improvement until the agencies can be expanded or reorganized to handle the increasingly complicated situations.

SENSITIVITY ANALYSIS

As in any water resource projection, various assumptions of basic parameters must be made to project future conditions. These assumptions, which reflect the best combination of available resources, often carry an undesirable degree of uncertainty and require special considerations before major decisions can be made. Recognition of those areas in which deviations are most likely can and does create a degree of awareness within those responsible for management, better preparing them for future developments.

This section of the report, therefore, will be devoted to the identification of those major areas affecting the water quality projections previously presented which, at this point in time, appear to have the greatest probability for change. For most of the cases, such as change in technology dealing with industrial wastewater treatment, it is impractical to gauge precisely the effects of changes, and only the general direction of the variations can be explored.

POPULATION AND WASTEWATER FLOWS

Population is the key factor in a wastewater flow projection, as it is the base upon which all other variables depend. The population projections themselves are subject to uncertainties and are seldom much more than simple extrapolations of historical data. They are, however, based on expected economic growth and policy decisions which may also change. The net effects of inaccurate population projections are that the

projected wastewater flows will not be realized. Underestimates will result in a lack of adequate wastewater treatment plant capacities or overloaded conditions, and overestimates will result in increased and excessive costs of treatment.

Wastewater loadings which are also a product of population and per capita loading rates, create the need for adequate removal efficiencies. Errors in projected wastewater loadings, basically due to faulty population projections and inadequate assessment of per capita loading trends, can result in inefficient treatment or added expenditures for better facilities which are not needed. An important or influential factor in the future will be the probability of increasing per capita loadings as the use of garbage grinders and industrially pretreated wastes are channeled to municipal wastewater treatment plants.

SOCIO-ECONOMIC CONCEPTS

Economic concerns also impact greatly on water use and water quality demands. Regional economies, which are a basic parameter in computation of projected populations, influence water demands in two basic ways. First, the per capita use rates are directly affected and noticeably higher in areas of highly industrialized and urbanized development. Secondly, in areas of high per capita incomes, the demand for domestic and recreational waters is much higher and must be accounted for in projected data. Errors in adequately assessing these economic trends can result in faulty per capita loadings, unrepresentative population estimates, and in the long run misleading wastewater projections.

Social tastes also have an important influence on water demands. Recent years have shown that changing social concepts have resulted in increasing rather than decreasing water demands. Increased per capita incomes have been accompanied by increasing amounts of leisure time leading to growing demands for outdoor recreation, including water-based recreation such as swimming, boating, and fishing. Changes with respect to the public preferences of a more affluent society are also areas of increasing impact as increasingly complex products require significant increases in gross water use during production processes.

TECHNOLOGICAL CONSTRAINTS

Technology, what some ecologists claim created most of the environmental problems now faced, may be called upon to cure our ills at least in the near future. Technological advances have brought us new products, new processes, new or different raw materials, and improved methods for handling water all at the expense of increased demands on water and degraded water-courses. As peculiar as it might seem, changes for the better in technology up to this point in time have not been direct results of the concern for good water quality, but rather results

of sewer charges and the aim for increased economy and productivity. Only recently, with increased environmental awareness and regulatory legislation, has technology been put to use to correct a worsening water quality situation.

In the future, several factors will affect technology and in the long run water quality. Changes in industrial production processes can either increase or decrease the water use per unit output. Increases in water consumption can be expected as production of more complicated products containing exotic chemicals which require higher degrees of refinement are developed. Conversely, decreases can be expected as more efficient processes make better use of recirculation practices. Other factors which can complicate treatment processes are the increasingly complex makeup of wastewaters, solid waste leachates, and the types of pollution for which no corrective technology now exists.

Any forecasts of future water demands, particularly industrial, must take into account possible technological changes. Advances in the near future are, however, very difficult to predict as breakthroughs which seem imminent may take many years to develop. Also, technological developments may be available long before implementation is possible, mainly due to cost effectiveness. An encouraging note with respect to compliance of water quality standards is that "best practiceable and best available" forms of technological treatments are both based upon forms of technology already available and future or unexpected advances can only result in an improved situation for water quality.

MANAGEMENT AND POLICY DECISIONS

Policy decisions perhaps do not directly affect wastewater projections, but definitely do affect both now and in the future, what technology is used, what population concentrations are acceptable, what economic policies will be pursued, and what social attitudes will prevail regarding water quality. A primary management decision which impacts on water quality itself is the agreement of what regulatory agencies (Federal, State, or local) will have what control and input toward corrective actions to be undertaken. A second impact is tied to the many problem areas previously identified which are demanding immediate attention. The decision of what areas are most critical and which will receive government subsidies and study priority will certainly effect what areas will realize the most improvement in the future. Forecasting water demands, therefore, must take into account the overriding effect of management policies regarding government subsidies and study priorities.

Policies regarding the desired levels of water quality in streams also directly affect the demand for suitable waters. Standards represent a compromise between demands for uses of water-based recreation, water supply, aquatic purposes, and waste disposal. Achievement of these

standards can be accomplished through many different alternatives. Increasing the assimilative capacity of water courses; levying effluent charges to decrease flow rates; material recovery and by-product production; higher levels of waste treatment; redistribution of effluent to avoid heavy concentrations; and the provision of additional waters to assist natural capacities are all acceptable alternatives. Depending on which alternative or combination of alternatives for improving water quality are chosen, both the water demand and cost of improvement will be substantially different.

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CHAPTER IV

MEANS TO SATISFY THE NEEDS

This chapter includes a description of those measures that can be employed to meet present and future water quality needs. The measures are discussed in terms of types or methods of treatment and management/legislative actions. The physical system alternatives are covered first in order to provide a brief outline of the actual hardware and the methods that may be used to reduce the pollution from both point and non-point sources. Implementation of these treatment facilities is dependent, however, on sound legislation and enforcement actions. Presently, Public Law 92-500 serves as the best means of implementing the measures needed to meet future water quality goals and solve the water quality problems identified in the preceding chapter. The concluding section of this chapter includes a discussion of those sections of P.L. 92-500 that are most pertinent to the water quality in Chesapeake Bay.

PHYSICAL SYSTEM ALTERNATIVES

There are two basic approaches to physically controlling increasing volume of wastewater flows. One of them lies at the source of the problem, which involves installation of water saving devices and methods that cut down or limit the volume of waste generated. The other approach concerns the various methods and equipment available for treatment and disposal of our waste products after generation.

The following paragraphs outline those physical devices, controls, or alternatives which are currently available to help satisfy our water quality needs. The first alternative, or water use technology, is currently the only physical means available to limit the volume of waste generated. All other alternatives mentioned here deal with the treatment of wastewater flows after generation. Discussion of each will be limited to a brief description along with a statement of the proven success or shortcomings of each alternative.

WATER USE TECHNOLOGY

This means is actually a method which limits the production or per capita comsumption of water and altimately wastewater flow. It usually involves a "fine-tuning" of plumbing devices which will use less water to do the same job. Pricing policies, which usually levy higher water costs in rapidly developing areas, are actually management actions which implement the hardware and will be discussed later.

Among the plumbing providsions are toilets which use less than the conventional 3.5 gallons per flush, pressure relief valves which limit water pressures to less than 60 p.s.i., customer eduction programs which encourage the wise use of water, and shower heads which limit flows to 3.5 gallons per minute. Enforcement of the installation of these facilities has been difficult, mainly because of the lack of facilities, the additional costs for refitting older devices, and follow-up adjustments. Trends have shown that pricing policies and voluntary reduction programs have not been as effective as was hoped, and plumbing code revisions seem to hold the most hope in the future.

INCREASED INDUSTRIAL TREATMENT AND RECIRCULATION

Recirculation and increased industrial treatment work closely together to reduce both the ultimate discharge volume and concentration of pollutants. In keeping with the requirements of present legislation, improvement in treatment technology (percent pollutant removal) will most likely result in water of better quality. This in turn will result in an increased ability of industrial plants to reuse this water in the production process and decrease volumes of flow to the rivers. It should be mentioned that because of the widely varying constituents of industrial discharges, some groups of industries may find clean-up both increasingly difficult and very expensive. The Paper and Allied Products, the Primary Metals, and the Petroleum Industries, which are prominent among Bay Area industries, are currently experiencing difficulty meeting standards.

Several alternatives for industrial treatment have been proposed and are under consideration. Because of the many differing types of treatment procedures used in industry no attempt to list these procedures will be presented here. However, the municipal treatment section will present a discussion of the typical types of wastewater treatment.

Two specific alternatives are pre-treatment and by-product recovery. Pre-treatment of industrial wastes remove special pollutants prior to discharge in municipal sewers. This is currently, and may continue to be, a feasible alternative which can save industry a considerable amount, especially if discharges are reasonably small. The potential use or sale of waste by-products of the industrial process will also create incentives for industry to remove these pollutants as opposed to dumping them in watercourses. In the pulp and paper industries for example, lingosulfates or pulp wastes can be synthesized to produce artificial vanilla flavoring and other valuable acetic acids.

COOLING OF THERMAL WASTES

Three methods of cooling the heated waters of power plants are cur-

rently available. In wet towers, the hot effluent is exposed to air circulating in a hyperbolic-shaped tower. As water evaporates, heat is lost. Two problems associated with this method are rather high water losses and fog formation on cold days. Dry towers pass the effluent through a series of pipes over which cool air is passed and heat is lost by radiation. This process controls the water loss more effectively but costs 2-3 times as much as the former. Cooling ponds are also a possible solution, but the requirements for larger areas and the potential radioactive components of nuclear power plants often limit its usefulness.

INCREASED MUNICIPAL TREATMENT AND WASTEWATER RECYCLING

Increasing both the capacity and pollutant removal capabilities of Bay Area sewage treatment plants can contribute greatly to the improvement of the surface waters of Chesapeake Bay. Emphasis can also be placed upon the construction and enlargement of regional sewage treatment plants which have shown the ability to treat wastes more effectively as well as more economically. Larger facilities also relieve overloading due to combined sewers and enable presently unserved areas to receive wastewater treatment.

Three types of treatment are currently available in municipal wastewater treatment plants; primary, secondary, and advanced. Primary treatment is usually the first stage in treatment in which nearly all floating or settleable solids are removed by screening and sedimentation processes. Seocndary treatment uses biochemical action and removes virtually all floating and settleable solids in addition to approximately 90 percent of the BOD and suspended solids. Secondary treatment effluent is usually chlorinated at the end of the treatment process to destroy most of the remaining bacteria. Advanced or tertiary treatment includes all of the primary and secondary features as well as removal of nutrients such as nitrogen, phosphorous, and a very high percentage of suspended solids.

Varying types of unit treatment processes are combined to make up primary, secondary, and advanced treatment and are classified as physical, chemical, or biological in nature. Table 7-47 lists some of the common unit processes used for treating municipal wastes. Industrial waste treatment procedures are much the same, differing only by specialized or modified processes which remove pollutants not commonly found in municipal wastes. Table 7-48 lists the range of average removal percentages for different treatment processes. Combination of these processes vary widely from plant to plant, depending mostly on the amount of flow, available monetary resource, and degree of removal required. Figure 7-22 shows the unit processes included in the Lake Tahoe Sewage Treatment Plant, a 7.5 mgd facility which incorporates advanced waste treatment.

Recycling or reuse of treated municipal wastewaters will become more feasible and desirable in the future as both the degree of treatment and discharge volumes increase. Incorporation of recycling can result in lower water treatment costs, less freshwater usage, less discharge of polluted effluents, and ultimately cleaner receiving waters. Current recycling alternatives include: the direct use of municipal effluents by industry; the partial reuse of treated waters for municipal services which do not require water of the highest quality; and the direct reuse of effluents for all municipal needs. Both the first and second alternatives have shown promise and have proven environmentally sound as well as cost effective. The third alternative may be difficult, however. The major problem is that total reuse requires changing personal attitudes into acceptance of the fact that effluents are indeed safe and may even be better than the water which is initially withdrawn from the river.

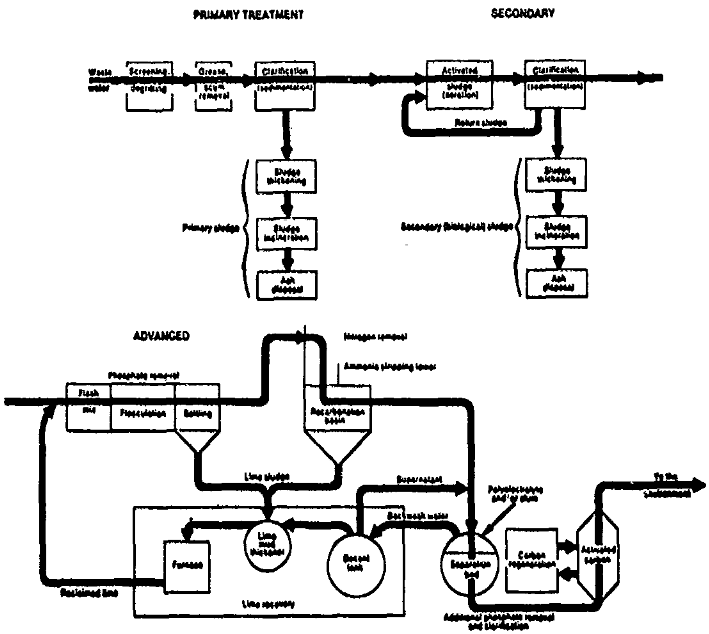

Figure 7-22: Lake Tahoe Sewage Treatment Plant Diagram

TABLE 7-47
WASTEWATER UNIT TREATMENT PROCESSES

PHYSICAL	CHEMICAL
Grit Chambers	Carbon Adsorption
Screening	Ammonia Stripping
Comminution	Chemical Coagulation (Flocculation)
Equalization	Ion Exchange
Flotation	Neutralization
Thickening (Gravity)	
Sedimentation	**BIOLOGICAL**
Filtration	
Vacuum Filtration	Trickling Filter
Centrifugation	Activated Sludge
Microscreening	Lagoons (aerated)
Drying Beds	Lagoons (anaerobic)
Incineration	Oxidation Ditch
Oil Separation	Nitrification-Denitrification
Reverse Osmosis	Digestion (aerobic)
	Digestion (anaerobic)
	Stabilization Ponds
	Rotating Biological Disks

Source: Department of the Army, Design of Wastewater Treatment Facilities, 12 August 1975 (40)

TABLE 7-48
BACTERIA REMOVAL EFFICIENCIES OF UNIT PROCESSES

Process	Percent Removal
Coarse Screens	0 - 5
Fine Screens	10 - 20
Grit Chambers	10 - 25
Sedimentation (Primary)	25 - 75
Chemical Coagulation	40 - 80
Trickling Filters	90 - 95
Activated Sludge	90 - 98
Chlorination of Treated Sewage	98 - 99

Source: (2)

Sludge disposal, a problem which will increase markedly as both flows and degree of treatment increase, has been attempted to be dealt with in various ways. Unfortunately, several unacceptable results have accompanied efforts such as incineration and pelletization, leaving land disposal as the leading alternative. Several processes for reducing the hygenic hazards and increasing acceptability of sludge for land disposal are available. Some of the more common processes are pasteurization, composting, heat drying, chemical oxidation, and digestion. Each of these processes have proven acceptable for land disposal with appropriate land types and management practices.

DEEP WELL INJECTION OF WASTEWATER

Deep well injection of waste products consists of a pumping system and a well drilled into the mantle far below the water table to a permeable rock strata bounded by two impermeable rock layers. The permeable rock strata must be a sedimentary rock, such as limestone or sandstone, capable of transmitting fluids and porous enough to hold large quantities of liquid in the spaces between the grains of the rock. Depth of the wells are usually between 1,000 and 6,000 feet deep, although some are shallower than 1,000 feet and others are as deep as 12,000 feet. Wastes put into the wells must also have a low enough solid content to avoid filling the pores of the permeable rock stratum.

This method has proven both simple and economical, being especially advantageous to industries that must find various methods of disposing of their highly toxic waste products. However, the volumes available for disposal are usually limited. The major problem experienced with implementation of deep well injection in the Chesapeake Bay Area has been largely due to an inadequate understanding of the limits of the impermeable geologic structure and aquifer characterisitcs in any particular area. Also, the desire by the States to protect underground water supplies has restricted further development of this alternative. However, in a joint study by the Departments of Defense and Interior in 1976, a geologic evaluation of waste storage potential in aquifer systems of the Atlantic Coastal Plain has begun to collect data which will be of great use in assessing the potential of deep well injection in the future.(43).

LAND TREATMENT OF WASTEWATER

In a land treatment operation, secondarily treated wastes are transported to the land treatment site instead of being disposed of in the watercourses. The effluent is then stored, chlorinated, and applied to the land surface by a variety of basic means. The underlying concept is based upon the use of the soil mantle and its vegetative cover which acts as a "living filter" to remove pollutants. By this process the oxygen demanding substances are destroyed by oxidation, the nitrogen and phosphorous

consumed by plant growth, and the purified water returned to the ecosystem by groundwater recharge. Heavy metals are also immobilized by adsorption on soil particles.

The specific type of land treatment system best suited for an area depends upon local hydrologic and geologic considerations such as soil type, permeability, natural water table, underlying aquifers, and upon the topography. The basic disadvantage of this system of disposal is that the large areas requried for treatment do not entirely meet the criteria for safe disposal. However, several areas in the Chesapeake Bay Region and especially the Washington Metropolitan Area are strongly considering this alternative and have found suitable areas for disposal.

RUNOFF CONTROLS

Urban and rural runoff controls are perhaps one of the most important and least understood means to satisfy related water quality problems. The basic problem lies in the fact that relatively little information is available or known regarding the constituents of surface runoff or storm drain discharges to adequately treat them.

Present emphasis has been placed on development of physical control structures which limit the amount of sediment entering the waterways. Agricultural runoff controls which have proven most effective are contour plowing, ridge planting, sedimentation ponds, terraces, and diversion and treatment of wastes from livestock feed yards. Urban controls consist mainly of adequate or separate storm drains and the possible installation of retention basins which store runoff for later treatment or disposal.

ALTERNATIVE WASTEWATER DISINFECTION

Several alternatives are available to both limit the growing problem of chlorine toxicity near wastewater outfalls and provide adequate disinfection at the same time. Among the most promising are the activated carbon system, ultraviolet radiation, and ozonation. Each of these methods has proven effective but differ somewhat from the others in basic operating concept.

Activated carbon filters can be used either as a dechlorinator for systems using chlorine disinfection or as a taste and odor eliminator for systems with advanced waste treatment. The carbonaceous material is actually a form of carbon which is highly adsorbent to chlorine, particularly when granulated or powdered. The disinfection or dechlorination procedure consists basically of passing pressurized water through beds of activated carbon to remove bacteria and excess chlorine. A drawback to this process is the increased cost of treatment necessitated by lining

steel or iron pipes with plastic to combat the highly corrosive power associated with the carbon element.

Ultraviolet radiation disinfection involves the exposure of water to several quartz-mercury vapor arc lamps which emit ultraviolet radiation at varying wavelengths purifying the water. The advantages of this system are that no foreign matter is injected into the water, water exposure times are very short, and that overdoses produce no side effects. Disadvantages include the increased use of electric power, additional maintenance and supervision necessary to assure uniform disinfection, the requirement of higher treated wastewater to avoid ultraviolet absorbtion by particulate matter, and the inapplicability of this method to large volumes of water. Several attempts have been made to implement ultraviolet radiation throughout the United States, however, the high electrical cost has limited it expanded use.

Ozonation, on the other hand, has become increasingly cost effective and is being studied at the Fairfax, Virginia, and the Blue Plains Sewage Treatment Plants in the Chesapeake Bay Area. Ozone is a blue, pungent smelling, unstable gas existing as an oxidized form of oxygen. Disinfection by ozonation is provided by spraying water into an ozone contained atmosphere. The ozone, which is produced on-site from oxygen, is usually applied through an injector type device or by diffusing it upward into the water through a well baffled mixing chamber. The advantages of using ozone as a disinfectant are: its powerful oxidizing powers which eliminate taste, odor, and color; its effectiveness over a wide range of pH and temperature; the short contact periods; and that overdoses produce no danger as is the problem with chlorine. The disadvantages, which are being minimized through increased research, are basically the higher electrical costs associated with the production of ozone and the decreased flexibility to cope with changes in wastewater flow. Both studies at Blue Plains and Fairfax, however, indicated that ozone for tertiary treatment is feasible and cost competitive with the activated carbon process.

MARINE SANITATION AND SPILL PREVENTION SYSTEMS

The physical means for prevention of overboard discharge of wastes and the achievement of "zero" discharge consists simply of the installation of waste holding tanks in boats and vessels along with adequate pumping and treatment facilities at the marinas. Interim measures, which limit or partially treat domestic wastes, consist of flow-through devices such as recirculation chemical toilets, controlled volume flush toilets and macerator chlorinator units. These devices can also be used when adequate marina facilities are constructed in the future.

Accidental oil spills due to collisions will be hard to prevent by any means. However, improved navigation and directional guidance systems

may decrease the probability of accidents in the future. Improvement in loading and unloading facilities dockside along with better control of bilge discharges should help alleviate the oil problem also.

IN-STREAM MODIFICATIONS

Improvement in water quality by in-stream modifications generally attempts to make better use of the assimilative capacity of the waterway. Physical methods for accomplishing improved assimilative capacity are flow augmentation, reservoir mixing, in-stream aeration, and effluent redistribution. Flow augmentation from reservoirs can prove valuable during periods of extremely low flow but is not considered an acceptable alternative to adequate sewage treatment. Reservoir mixing destratifies the waters of an impoundment and can provide a better quality of water for downstream users. Artificial reaeration techniques add oxygen to the water by fixing aeration devices in the beds of streams where needed to replenish the dissolved oxygen supply and prevent anaerobic conditions. Transferring a portion of the wastes from one location, which is overloaded and lacks adequate assimilative capacity, to alternate locations may relieve degraded conditions. Again, this alternative measure should not be considered a substitute for adequate sewage treatment.

MANAGEMENT ACTIONS

As previously mentioned, the physical system alternatives serve as the tools for improving water quality. However, it has been found historically that improved water quality cannot be maintained in the absence of sound management structures and strong legislative control. Management actions, therefore, are very important. The establishment of stream water quality standards, effluent standards, waste treatment practices, erosion abatement procedures, and other bases for developing coordinated river basin water quality plans are all dependent upon legislative control. Also, methods for reducing the demand for increased wastewater treatment are dependent on legislative actions which give the local water agency authority to implement water conservation practices.

For the present and near future, the requirements of the Federal Water Pollution Control Act Amendments of 1972 appear to serve as a schedule or means to implement the desired water quality goals for both the Chesapeake Bay Region and the United States. This section will discuss first, the management options available to reduce the demand for water and second, the major provisions of the various sections of P.L. 92-500. Also included are the provisions of recent supplemental legislation having a direct impact on water quality and its management.

DEMAND MODIFICATION

Obviously, the easiest and most effective way to modify the demand for

wastewater in a specific area is to either reduce the use per capita or limit growth. Limiting population growth in areas already experiencing water quality problems is very effective in reducing demand. However, this is not very easy because agencies which currently have knowledge about water quality problems caused by excessive population have little authority to control this type of development. Management alternatives which seek to reduce the generation of flows are available, although not often thought of because they directly involve changing the social practices to which we are accustomed. They are pricing policies, sewer moratoriums, consumer education, and plumbing code provisions. Each will be discussed briefly at this time.

PRICING POLICIES

Pricing policies seek to reduce consumption of water by levying higher water rates for those areas where the demand is high. Among the differing policies being investigated are: differentiation by service district which lowers prices for small, built-up areas as contrasted with rapidly developing districts where higher prices would be assessed; and differentiation by increasing block rate which assesses higher rates to single family residences as usage increases. Feasibility studies are currently underway in several areas to address the legal requirements for implementing a pricing program, as some question currently exists as to whether it is, in fact, legal for a public water supplier to set prices in order to manipulate demand.

SEWER MORATORIUMS

Sewer moratoriums have been used in areas where demands for water and sewerage service exceed the ability to provide adequate treatment. These moratoriums prohibit either the construction of new sewerage systems or the extension of old systems. This type of demand modification has been used effectively in the Washington Metropolitan Area where counties in the surrounding metropolis have implemented moratoriums both as emergency measures and staging devices to control the rapid population growth.

CONSUMER EDUCATION

Consumer education practices stress the voluntary conservation of water. The basic elements of programs of this type include radio announcements and the distribution of handbooks which prepare listings of major appliances of all brands detailing their water consumption characteristics. More advanced programs include door-to-door distribution of water saving packages containing instructions for correcting leaky and excessive water using appliances as well as dye tablets to help detect leaks within the home.

PLUMBING CODE PROVISIONS

Plumbing code provisions serve as the framework for implementing the physical devices mentioned earlier. Enactment of legislation, on a local basis, can force the installation of water saving devices in all new structures and the retro-fitting of these devices in existing structures. Major problems with this method lie not in the management sense but rather in the devices themselves which are experiencing some difficulties in working properly.

P.L. 92-500 (FEDERAL WATER POLLUTION CONTROL ACT OF 1972)

The Federal Water Pollution Control Act Amendments of 1972 as amended by P.L. 93-207, December 28, 1973; P.L. 93-243, January 2, 1974; P.L. 93-592, January 2, 1975; and P.L. 94-238, March 23, 1976, set the basic goal of the "restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters." Five basic sections provide for attainment of this goal by focusing upon research and related programs, grants for the construction of treatment works, standards and enforcement, permits and licenses, and administration. Each of the following paragraphs describe the provisions of the more important sections of the Act.

TITLE I–RESEARCH AND RELATED PROGRAMS

Section 101 provides the goals and policies of the Act itself. The national goal has been established as the elimination of the discharge of pollutants into waters by 1985. An interim goal provides for the protection of fish, shellfish, and wildlife and provides for recreation in and on all waters by July 1, 1983. Part (d) also provides that the EPA (hereafter referred to as the Administrator) shall administer all the sections of this Act.

Section 102 requires that the Administrator prepare or develop comprehensive programs for preventing, reducing, or eliminating the pollution of navigable waters and ground waters and improving the sanitary condition of surface waters. At the request of a governor of a State, the Administrator may grant funds, not to exceed 50 percent of the administrative expenses, to develop these plans provided the agency involved adequately represents the State interests and is proven capable of developing an effective continuing plan for the river basin in question.

Section 104 provides the Administrator with the authority to conduct research, initiate investigations, authorize grants, provide training, and disseminate information concerning various categories of water pollution. Among these are: research on the harmful effects of pollutants on the health and welfare of persons; the financing of pilot programs concern-

ing manpower development and training for those entering the field of operation and maintenance of treatment works; grants for the purpose of developing and demonstrating new and improved methods for prevention, removal, reduction, and elimination of pollution in waters; studies in cooperation with the Coast Guard concerning removal of oil and hazardous substances from waters; studies indicating the kind and extent of effects on health and welfare from the presence of pesticides; studies in cooperation with the Secretary of the Army, Secretary of Agriculture, and the Water Resources Council on the effects of sedimentation on estuaries and their environs; research on devices, systems, incentives, pricing policies, and other methods for reducing the total flow of sewage; research in cooperation with the Secretary of Agriculture to determine new and improved methods of preventing, reducing, and eliminating pollution from agricultural sources; grants to institutions of higher learning for the purpose of conducting and reporting on the nature of river systems; and studies of effects and methods of control of thermal discharges.

Section 115 directs the Administrator to identify the location of in-place pollutants in harbors and navigable waterways. In addition the Administrator is authorized, through the Secretary of the Army, to make contracts for the removal and appropriate disposal of dredge material from critical port and harbor areas.

TITLE II–GRANTS FOR CONSTRUCTION OF TREATMENT WORKS

Section 201 states the purpose of Title II as the development and implementation of waste treatment management plans and practices which achieve the goals of this act. These plans and practices are directed to provide for the application of "best practicable" waste treatment technology before discharge into receiving waters. Also, the waste treatment management is directed to be approached on an area-wide basis providing for the treatment of all point and non-point sources of pollution. Part (g) authorizes the Administrator to make grants to any State, municipal, or interstate agency for the construction of publicly owned treatment works.

Section 202 states that the amount of a grant for treatment works from funds authorized for any fiscal year after June 30, 1971 shall be 75 percent of the cost of construction. Grants made prior to this date may be increased to this percentage provided that adequate sewage collection systems are to be part of the facilities and that the appropriate State authority certifies that the quantity of available ground water will be insufficient or inadequate unless effluents from publicly owned treatment works are returned to the ground water table.

Section 208 provides for the development and implementation of area-wide waste treatment management plans for areas, which as a result of

high concentrations of urban and industrial development, have substantial water quality control problems. These plans are directed to be consistent with the planning process directed in Section 201 and any information provided by statewide regulatory plans and programs under Section 303. Among the areas to be covered by these plans are: the identification of treatment works necessary to meet anticipated municipal and industrial waste treatment needs over a 20-year period, annually updated; the establishment of construction priorities for such treatment works; the establishment of a regulatory plan to implement Section 201; the identification of those agencies necessary to carry out the plan; the identification and proposed control measures to deal with agricultural related non-point sources of pollution; construction activity sources of pollution; and salt water intrusion into rivers, lakes, and estuaries from reduction of freshwater flows. Part (h) of this section also authorizes the Administrator, acting through the Secretary of the Army and the Chief of Engineers, to consult with and provide technical assistance in developing an areawide planning process upon request of the governor of the State in question. Grants for payment of the reasonable costs of developing and operating a continuing areawide waste treatment management process shall be made by the Administrator to include up to 100 percent of the cost for the initial 2-year planning period and 75 percent in each succeeding fiscal year.

In the Chesapeake Bay Area seven "208" areas have been designated by the governors of the States of Maryland, Virginia, and Delaware and approved by the EPA. Table 7-49 lists the area, surrounding counties, and designated management agency for each area. In most of those areas, organization of management structures and personnel are completed and studies are expected to begin in the near future.

Section 209 requires the President, acting through the Water Resources Council, to prepare a Level B Plan under the Water Resources Planning Act for all basins of the United States by January 1, 1980. Furthermore, priorities in the preparation of such plans shall also be given to those basins within areas designated by Section 208 of this Act.

TITLE III–STANDARDS AND ENFORCEMENT

Section 301 sets the effluent limitations for point related sources of pollutants. For all point sources other than publically owned treatment works, application of "best practiceable control technology currently available" must be initiated no later than 1 July 1977 and application of "best available technology economically achievable" must be initiated by 1 July 1983. In publicly owned treatment works effluent limitations must be based upon secondary treatment (85 percent BOD removal) by 1 July 1977 and application of best practiceable waste treatment technology over the life of the works must be implemented by 1 July 1983.

TABLE 7-49
208 PLANNING AREAS IN THE CHESAPEAKE BAY REGION

Baltimore, Md.	Anne Arundel, Baltimore, Carroll, Harford, and Howard Counties; Baltimore City	Baltimore Regional Planning Council 201 St. Paul Street Baltimore, Maryland 21202
Washington Metropolitan Area	District of Columbia and Montgomery, Prince Georges, Arlington, Fairfax, and Loudoun Counties; Cities of Alexandria, Fairfax, and Falls Church	Metropolitan Washington Council of Governments 1225 Connecticut Ave., N.W. District of Columbia 20036
Fredericksburg, Va.	Spotsylvania, Caroline, Stafford, and King George Counties; City of Fredericksburg	Rappahannock Area Development Commission 913 Charles Street P. O. Box 863 Fredericksburg, Virginia 22401
Richmond, Va.	Hanover, New Kent, Charles City, Henrico, Chester, Powhatan, Goochland, Dinwiddie, Prince George, Surry, Sussex, and Greensville Counties; Cities of Colonial Heights, Hopewell, Petersburg, and Richmond	Richmond-Crater Planning District Commission 2825 Crater Road, South P. O. Box 1808 Petersburg, Virginia 23803
Hampton Roads, Va.	City of Chesapeake, City of Suffolk, and Isle of Wight and Southampton Counties	Hampton Roads Sanitary District Pembroke 3 Office Building Suite 131 Virginia Beach, Virginia 23462
Sussex County, Del.	Sussex County	Sussex County Council P. O. Box 507 Georgetown, Delaware 19947

Source: National Profile of Section 208 Areawide Management Plans, July 1975, EPA (42)

Section 303 provides for the continuance of water quality standards and the implementation of a continuing planning process for each State. Part (c) provides that the governor of each State hold periodic public meetings for the purpose of reviewing applicable water quality standards. Identification of waters within State boundaries for which effluent limitations required by Section 301 are not stringent enough to meet applicable water quality standards is also required.

Under Part (e), continuing planning processes are required from each State for all navigable river basins of the State. These plans include: effluent limitations and schedules of compliance at least as stringent as those in Section 301; the incorporation of data supplied for plans required by Sections 208 and 201 of this Act; the total maximum daily load of pollutants for each section; procedures for revision; adequate implementation schedules; controls over disposal of residual wastes from water treatment processing; and an inventory and ranking of needs for construction of waste treatment works.

In the Chesapeake Bay Region, 18 separate 303(e) river basin segments are being prepared and have actually served as the major input of data for this report. Most of these reports are currently in draft form and State planning agencies are conducting public meetings to review their contents. All of the basins were expected to have draft plans available for public comment by 1 January 1977. Specific contents, such as implementation schedules and various treatment plant alternatives for each basin are beyond the scope of this report and will not be presented herein. Information of this type can be found in the drafts themselves and should be referred to for detailed information.

Section 305 requires the preparation of a State water quality inventory on a yearly basis. Each inventory is directed to include: a description of the water quality of all navigable waters in the State taking into account seasonal, tidal, and other variations; an inventory of all point sources of discharge; an analysis of the extent to which the elimination of pollution will achieve the goals of this Act; an identification of those waters which will or will not be expected to attain 1977 and 1983 goals; an estimate of economic and social costs necessary to meet the goals; and a description of the nature and extent of non-point sources. Information supplied by these reports has been of great value, especially in the preparation of Chapter II of this Report. Annual updates add to the existing data base and identify trends, better preparing Federal, State, and local planning agencies to make assessments of future loadings and expectant problem areas.

Section 307 outlines the toxic and pre-treatment effluent standards for both municipal and industrial complexes. Part (a) requires the Administrator to publish a toxic pollutant list to include any toxic pollutant for which an effluent standard will be established. This standard shall

take into account the toxicity of the pollutant, its persistence, degradability, the importance of affected organisms in the area, and the extent of a toxic pollutant on such organisms. Part (b) requires the publication of regulations establishing pretreatment standards for the introduction of pollutants into treatment works which are publicly owned. In order to assure that pollutants from industrially pre-treated sources do not cause violations of the municipal treatment plant effluent standards to which it flows, Part (c) requires simultaneous issuance of pre-treatment standards with the issuance of standards of performance for an individual treatment plant under Section 306.

Section 311 outlines the provisions for protection of waterways from oils and hazardous substances. Part (b) declares that it is the national policy of the United States that there should be no discharge of oil or hazardous substances into or upon the navigable waters and adjoining shorelines. Hazardous substances are defined as elements or compounds which, when discharged in any quantity into the waters of the United States, present an imminent and substantial danger to public health or welfare, including fish, shellfish, and wildlife. Authorization is given the President to remove or arrange for the removal of a discharge unless he determines such removal will be done properly by the owner or operator of the vessel or onshore facility in question. Liability for the cost incurred with clean-up of a spill rests directly with the owner or operator unless he can prove that the discharge was caused solely by an act of God, an act of war, or negligence on the part of the U.S. Government. Part (c) of this section provides for the development of a National Contingency Plan which plots an effective course of action to minimize the damage from the spills including containment, dispersal, and removal procedures.

Section 312 required the establishment, after consultation with the United States Coast Guard, of standards of performance for marine sanitation devices which were to be designated to prevent the discharge of untreated or raw sewage into or upon the navigable waters. Part (f) also provides the authority for more stringent discharge standards on a case-by-case and statewide basis.

Section 315 established a National Study Commission, now known as the National Commission on Water Quality (NCWQ), to make a complete investigation and study of the technological, economic, social, and environmental effects of achieving the effluent limitations and goals of this Act for 1983. The Commission is composed of five members from the Senate Public Works Committee, five members from the House Public Works Committee, and five members of the general public. Using approximately 17 million dollars and research with the National Academy of Sciences and other agencies, a final report on the results of the study, together with recommendations, is directed to be submitted to Congress three years after the enactment of this Act.

TITLE IV–PERMITS AND LICENSES

Section 402 provides the authority for administration of the National Pollutant Discharge Elimination System (NPDES). This system, enforced by the States and EPA, prohibits the discharge of pollutants by any person except as authorized in a NPDES permit. Prohibited discharges in any volume include: radiological discharges; any discharge which the Secretary of the Army through the Chief of Engineers finds would impair navigation; any discharge objected to by an EPA regional administrator; and any point source in conflict with a "208" plan. Those discharges not requiring a discharge permit under this section are: discharges of sewage from vessels; water injected into wells to retrieve oil; chemicals used in aquaculture projects; dredge spoil; storm runoff from separate sewers; and agricultural and silvacultural activities except large animal confinements and fish hatcheries.

Issuance of NPDES permits, for a period not to exceed 5 years, is the responsibility of the EPA. However, authority may be transferred to a State upon the request of the governor and proof of capability by the State water agency. Effluent limitations issued in the permits must comply with effluent limitation requirements under Sections 301, 302, 306, 307, 308, and 403 of this Act. A schedule of compliance is also required in issuance of permits to dischargers not currently complying with applicable effluent standards and limitations.

Section 404 authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits after opportunity for public hearings, for the discharge of dredged or fill material into the navigable waters. The Administrator is also authorized, after consultation with the Secretary of the Army, to prohibit the specification of any defined area as a disposal site. He may also deny use of an established area whenever he determines, after opportunity for public hearings, that discharge of such materials will adversely impact upon fish, wildlife, or recreation in the area.

TITLE V–GENERAL PROVISIONS

Section 503 established in the EPA, a Water Pollution Control Advisory Board composed of the Administrator and nine members appointed by the President, none of whom were to be Federal Officers or employees. The members, serving three-year terms, were selected from various State, interstate, and local agencies concerned with the control of pollution. The Board is to advise, consult with, and make recommendations to the Administrator on policy matters relating to the function of the Administrator under this Act.

Section 515 established the Effluent Standards and Water Quality Information Advisory Committee which is composed of a chairman and eight

members appointed by the Administrator. Members serve terms of four years and are selected from the scientific community, qualified by education, training, and experience. The committee serves as a technical advisor by collecting and disseminating the latest scientific and technical information when the Administrator is required to propose the regulations required under Sections 304, 306, and 307.

Section 516 focuses on reports required from the Administrator to every new session of Congress on the progress taken toward implementation of the plans and provisions required by this Act. Specific areas to be reported on are: the progress and problems associated with Sections 102, 208, and 303 plans; the results of pollution control research; the progress and problems associated with the development of effluent limitations; the identification and status of enforcement actions; and the status of State, interstate, and local pollution control programs. Part (b) also authorizes the Administrator, in cooperation with the States, to prepare a comprehensive analysis of the national requirement for and the cost of treating municipal, industrial, and other effluents to attain the water quality objectives established by this Act.

TOXIC SUBSTANCES CONTROL ACT

The Toxic Substances Control Act extends Federal regulatory authority to substances that "may present an unreasonable risk to injury to health and the environment." Effective 1 January 1977, the Act requires the pre-market testing of substances to be promulgated after that date.

The Environmental Protection Agency is authorized through this Act to adopt rules requiring the testing of chemicals likely to be hazardous, although testing will not be required of all chemicals. Only those chemicals which the EPA can prove will present a risk of injury, will be produced in substantial quantities, and may reasonably be expected to result in extensive human or environmental exposures can be tested. Also, the EPA is authorized to publish a hazardous substances list and may block the manufacture of a chemical if it finds that testing should be done before the substance is manufactured. Finally, the Act provides that the manufacture of Polychlorinated biphenals (PCB's) be terminated by 1 January 1979 and all processing or distribution in commerce be prohibited by 1 July 1979.

AMENDMENTS TO SECTION 312 OF THE WATER POLLUTION CONTROL ACTS OF 1972

Ultimate authority for overboard dumping of domestic wastes stem from Section 312 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). This section, as amended on 2 January 1975, requires that all new ships meet "0" discharge requirements by 30

January 1977 and that existing ships comply by 30 January 1980. Guidelines have been set up by the EPA, and official standards and enforcement are the responsibility of the United States Coast Guard in their areas of jurisdiction. "0 discharge" in this case has been defined as no overboard dumping of raw wastes and will essentially require the installation of holding tanks or other suitable flow-through devices determined by EPA and USCG. Should an individual State feel the need for more stringent standards, they may apply to EPA in two ways for approval of their intended standards. By applying through Section 312 (f)3, State standards will be adopted by the EPA and the USCG will remain the enforcement agency. If, however, the States apply through Section 312 (f)4, the EPA will require that adequate marina facilities are installed by the State-Department of Health and that enforcement of these standards be accomplished by the appropriate State agency.

PROPOSED AMENDMENTS TO THE WATER POLLUTION CONTROL ACTS OF 1972

Several amendments to the Water Pollution Control Acts of 1972 have been proposed since the initial passage on 18 October 1972. Amendments which more clearly define the proposals of the initial Act were passed in each of the years following (December 1973, January 1974, January 1975, and March 1976). Current proposals in the House and Senate center around three major amendments: the authorization for fiscal year 1977 municipal sewage treatment plant construction grants; an amendment to Section 404 to revise requirements for dredge and fill permits; and an amendment to transfer authority of the municipal wastewater construction program to the States.

House Rule 3199, passed early in April of 1977, incorporates several of the aforementioned proposals. The bill includes sections to: provide a case-by-case extension of the July 7, 1977 secondary treatment deadline for municipal treatment plants; extend the July 1, 1977 deadline of best practicable treatment for industrial point sources; restrict the scope of Section 404 dredge or fill materials provisions; authorize the EPA to certify states to assume a larger role in the sewage treatment construction grants program; and obligate $17 billion in construction grants funding over 3 years, beginning in fiscal 1977. Approval by Senate committees is required, however, before these provisions can be formally adopted.

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CHAPTER V

REQUIRED FUTURE STUDIES

The alternative measures and management programs outlined in Chapter IV reflect the on-going efforts to combat the water quality problems in the waters of Chesapeake Bay. In addition to the on-going and completed studies and plans, it is recognized by experts in the water quality field that all is not known about water quality and the effects of our wastes upon the Bay Ecosystem. Future studies must continue in order that completed management plans may be modified in whole or part to respond to changing conditions or improved knowledge.

This chapter includes a discussion of those areas where information is still lacking and future studies are needed to enable water quality management agencies to better analyze problems and provide correcting measures. Also included is a discussion of the Chesapeake Bay Hydraulic Model, constructed by the Baltimore District, U.S. Army Corps of Engineers.

Based on the previous discussion of existing water quality problems and both the physical and management means currently available, it is obvious that a comprehensive water quality plan which is responsive to the needs of the entire Chesapeake Bay Region is necessary. As a part of any total management plan for Chesapeake Bay, this plan would be very important because of the complex interrelationships between water quality and the other resources of Chesapeake Bay. However, much coordination, investigation, and research will be needed before a truly effective water quality management plan for Chesapeake Bay can be implemented.

Of major importance are studies which will clearly define the transport and flushing characteristics, as well as the assimilative capacity of Chesapeake Bay. Currently, little is known about the cumulative effects of pollutant discharges and their dispersion patterns in this complex estuarine system. Complimentary use of hydraulic and mathematical model studies will be extremely helpful in assessing the effects of flow regulation, waste discharges, sediment deposition, and an overall understanding of the Bay.

As mentioned in Chapter III, toxic substances such as kepone, mirex, PCB's, DDT, lead, mercury, and others are causing some serious biological problems in Bay Area waters. Although methods of detection have progressed to the point where even the most minute pollutant concentrations can be detected, little is actually known of the long

range effects of these materials on the central nervous systems or reproductive capacities of aquatic species. Studies which would increase knowledge and aid the future control of these pollutants are: the effects of toxic substances on the reproductive and central nervous system capacities; the synergystic effects of two or more toxic pollutants in sub-lethal concentrations; and the effects toxic substances have on decreasing species resistance to those viruses normally found in an estuarine system.

Pollution from non-point sources such as agriculture, urban runoff, and erosion are serious water quality problems in various areas of the Chesapeake Bay Region. While these sources of pollution may not be hard to identify and some control measures are available, they are, however, difficult to evaluate in both magnitude and impact. Studies such as those being done by the Smithsonian Institution (33) and the Interstate Commission on the Potomac River Basin (34) are, for the first time, attempting to apply theoretical knowledge of non-point pollutants to investigations of actual areas. By measuring the magnitude and effects of non-point pollutant categories such as nutrients, coliform organisms, particulates, and acid mine drainage, abatement and treatment techniques as well as their associated costs have been developed for those areas. However, application of the information provided by this type of investigation will still be needed for all drainage basins of the Bay before any significant improvement can be expected in Chesapeake Bay waters as a whole.

Other water quality and pollution related study needs for the Bay Region include:

1) Studies which will develop an institutional-technical framework to implement an overall water quality management system for Chesapeake Bay.

2) Studies to determine the nature of long range effects from thermal discharges as well as the proper siting of nuclear power plants.

3) Studies to determine the best locations for additional water quality monitoring stations and methods for integration, storing, and analyzing the sample data.

4) Studies reanalyzing the feasibility of implementing water conservation policies and improved water saving devices as they apply to reduction of wastewater flows.

5) Studies to determine the effects of differing degrees of water quality improvement on the environment and the costs and benefits associated with these improvements.

6) Studies which focus upon the land use planning and management programs as an effective tool for growth co trol and, in effect, improved water quality.

7) Studies to find the best alternatives for fi disposal of sewage treatment plant sludges, exotic chemical wastes, an dged material.

8) Studies to determine the relative contribu on and the various types of nutrients to Chesapeake Bay, economical methods for overcoming problems such as nitrogen and phosphorous removal, and the current level of eutrophication in the Bay. Emphasis should be placed on the growing problem in the Northern Bay Area.

9) Studies which define the differing types a haracteristics of wetlands in the Bay, the stage of development at the majority of the wetlands are, and the net effects on water qu vetlands have as sediment traps or nutrient contributors.

10) Studies to determine the effects of low fre vater inflows on the salinity regimes, flushing characteristics, and w water dispersion patterns in Chesapeake Bay.

The Chesapeake Bay Hydraulic Model, authorized by ction 312 of the River and Harbor Act of 1965 and constructed by the Baltimore District Office of the U.S. Army Corps of Engineers, can also provide some of the physical data necessary for development of a comprehensive water quality plan for Chesapeake Bay. Because of its extensive applicability to water quality related subjects, hydraulic model usage has been increasing in recent years. Study capabilities of the model that will be particularly useful to the hydraulic engineers, biologists, water resource planners, scientists, and engineers involved in the water quality field include:

1) The salinity distribution within the Bay System, and interrelationships of significant parameters affecting salinity distributions.

2) The mechanics of estuary flushing.

3) Wastewater and heat dispersion.

4) Time passage of pollutant loads.

5) Investigation for better site locations of sewage treatment plants, sub-aqueous outfalls, nuclear and fossil fueled power plants, and port facilities.

6) Study of projects that involve both major changes in the freshwater inflow regime and alterations in existing estuarine hydraulic geometry.

Beginning in the spring of 1977, a one-year testing program is scheduled to commence and will address some of the more critical issues facing the Chesapeake Bay Estuary. Although a more detailed discussion of the tests planned and the overall capabilities of the hydraulic model may be found in Appendix 16, "Hydraulic Model Testing," a very brief review of the objectives of the three tests provided for in the initial year of testing will be presented here because of their close relationship to water quality.

The initial test will be the Chesapeake Bay Low Freshwater Inflow Test which, by studying the effects of low freshwater supplies on the salinity regime, will produce salinity data for the entire Bay Area during critical conditions. Emphasis will be placed upon developing time histories of tidal elevations and salinity concentrations for specific low flow conditions. The time required for the system to return to a state of dynamic normalcy following periods of depressed flow will also be determined.

The Baltimore Harbor Channel Study will assess the effects of deepening the harbor and approach channels to a depth of 50 feet. Emphasis will be placed upon identifying the changes a deeper channel would have upon tidal elevations, salinities, and current velocities.

The third test will be a combined Potomac River Estuary Water Supply and Wastewater Disposal Test. The primary objective of this test is to define the salinity regime and wastewater dispersion patterns in the Upper Potomac Estuary under several freshwater inflow conditions. Emphasis will also be placed upon determining the effect pumping water out of the estuary at Washington, D.C., will have upon the salinity regime and overall wastewater dispersion patterns.

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WATER QUALITY

GLOSSARY

abatement: the method of reducing the degree or intensity of pollution.

activated sludge: sludge that has been aerated and subjected to bacterial action. The activated sludge process is used in "Secondary Treatment" by continuously collecting and returning the bacteria rich sludge to aeration tanks where it is mixed with air and fresh sewage and allowed to remain for several hours.

advanced waste treatment: (AWT) wastewater treatment beyond the secondary (biological) stage. It includes removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids.

aeration: the process of being supplied or impregnated with air. Aeration is used in wastewater treatment to foster biological and chemical purification.

aerobic: referring to life or processes that can occur only in the presence of oxygen. Fish can live only in aerobic conditions.

anadromous fish: fish that ascend rivers from the sea to spawn. Yellow perch and herring are two anadromous species.

anaerobic: referring to life or processes that occur in the absence of oxygen.

assimilation: conversion or incorporation of nutrients into protoplasm. As aquatic organisms (such as algae) grow, they assimilate nutrients, thus helping the body of water purify itself.

bacteria: single-celled micro-organisms that lack chlorophyll. Some bacteria are capable of causing human, animal, or plant diseases; others are essential in pollution control bacause they break down organic matter in the air and in the water.

benthic region: the bottom of a body of water. This region supports the benthos.

bioassay: the use of living organisms to determine the biological effect of some substance, factor, or condition.

biochemical oxygen demand: (BOD) the quantity of oxygen required for oxidation of organic matter by organisms under specific conditions. Oxygen requirements of unstable material oxidized through the agencies of living organisms and in the presence of oxygen are usually expressed in terms of the amount of oxygen used in five days of incubation at 20 degrees C. This BOD_5 is generally considered to be about 68 percent of the ultimate BOD for domestic sewage.

biological treatment processes: wastewater treatment processes which intensify natural bacterial or biochemical action in order to stabilize, oxidize, and nitrify the unstable organic matter present in sewage. Trickling filters, activated sludge processes, and lagoons are examples.

biota: all the species of plants and animals occurring within a certain area.

biosphere: the portion of the earth and its atmosphere capable of supporting life.

chlorinated hydrocarbons: a class of generally long-lasting broad-spectrum insecticides of which the best known is DDT. Other similar compounds include aldrin, dieldrin, heptachlor, chlordane, lindane, endrin, mirex, benzene hexachloride (BHC), kepone, and toxaphene. Composed of chlorine, hydrogen, and carbon, these synthetic organic poisons kill by attacking the central nervous system.

chlorine: a poisonous gas applied to drinking water, sewage, or industrial waste for disinfection or oxidation or undesirable compounds. When properly applied, chlorine can kill more than ninety-nine percent of the bacteria in an effluent.

chronic:	marked by long duration or frequent recurrence.
coagulation:	a process whereby the natural repulsion between finely divided suspended particles (colloids) is reduced. Coagulation with the resulting flocculation (clumping) is used to remove suspended solids.
coliform organisms:	rod-shaped bacteria common to the intestinal tract of man and animals. The presence of coliform organisms is taken as an indicator that pathogenic organisms may also be present; however, coliforms themselves are harmless to man, and are, in fact, useful in destroying organic matter in biological waste treatment processes.
combined sewage:	sewage containing both domestic and surface water or stormwater. It includes flow in heavily infiltrated sanitary sewer systems, as well as flow in combined sewer systems.
concentration:	the weight of a substance dissolved in a unit volume of liquid normally expressed in miligrams per liter (mg/l).
cost effectiveness:	an economic evaluation of a project or program which compares anticipated benefits with the cost of the benefits. It is a measure of the economic efficiency of a particular alternative.
denitrification:	a microbial process in which nitrate is transformed into nitrogen gas.
desalinization:	the process of removing salt from sea or brackish water, commonly by distillation.
digestion:	decomposition of organic matter in which living organisms gasify, liquify, and mineralize organic pollutants. Typically, raw sludge is digested anaerobically producing a stabilized sludge of considerably less volume and yielding methane as a by-product.

discharge:	any addition of any pollutant to any waters from any point source.
dispersant:	a chemical agent used to break up concentrations of organic material. Dispersants are used to clean oil spills.
dissolved oxygen (DO):	the oxygen dissolved in water or sewage. Adequate dissolved oxygen is necessary for the life of fish and other aquatic organisms. Low dissolved oxygen concentrations generally are due to the discharge of organic solids having a high BOD, the result of inadequate waste treatment.
ecology:	the interrelationships of living things with one another and to their environment; the study of such interrelationships.
ecosystem:	the interacting system of a biological community and its nonliving environment.
effluent:	the substance of a discharge. The discharge may be partially or completely treated or in its natural state.
enrichment:	the addition of nitrogen, phosphorus, carbon compounds or other nutrients into a lake or other waterway, greatly increasing the growth potential for algae and other aquatic plants. Most frequently, enrichment results from the inflow of sewage effluent or from agricultural runoff.
environment:	the sum of all external conditions and influences affecting the life, development, and ultimately, the survival of an organism.
estuaries:	areas where the fresh water meets salt water. Estuaries are delicate ecosystems; they serve as nurseries, spawning, and feeding grounds for a large group of marine life and provide shelter and food for birds and wildlife.

eutrophication: the normally slow aging process by which a lake evolves into a bog or marsh and ultimately assumes a completely terrestrial state and disappears. During eutrophication, the lake becomes so rich in nutritive compounds, especially nitrogen and phosphorus, that algae and other microscopic plant life become superabundant, thereby "choking" the lake, and causing it eventually to dry up. Eutrophication may be accelerated by many human activities.

habitat: the sum total of environmental conditions of a specific place that is occupied by an organism, a population or a community.

heavy metals: metallic elements with high molecular weights, generally toxic in low concentrations to plant and animal life. Such metals are often residual in the environment and exhibit biological accumulation. Examples include mercury, chromium, cadmium, arsenic, and lead.

hydrology: the science dealing with the properties, distribution, and circulation of water.

industrial user: any industry that introduces pollutants into public sewer systems and whose wastes are treated by a publicly owned treatment facility.

infiltration: the flow of a fluid into a substance through pores or small openings.

infiltration/inflow: the total quantity of water from both infiltration and inflow without distinguishing the source.

inflow: the water discharged into a sewer system from such sources as roof leaders, drains, cooling water discharges, manhole covers, cross connections from storm sewers and combined sewers, catch basins, surface runoff, and street wash waters.

kepone: a highly toxic organic poison (see chlorinated hydrocarbons).

leaching: the process by which soluable materials in the soil, such as nutrients, pesticide chemicals, or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

MPN: the most probable number of coliform bacteria present in a given volume (generally 100 ml) of a liquid sample, as measured by the techniques given in "Standard Methods for the Examination of Water and Wastewater," latest edition.

nitrification: a microbial process in which ammonium ions are transformed into nitrate.

nonpoint source pollution: pollution originating from land runoff where no specific outfall (point source) can be identified. Examples are storm-water that runs off of agricultural fields, feedlots, and city streets; sediment from construction sites; and acid mine drainage.

nutrients: elements or compounds essential as raw materials for organism growth and development; for example, carbon, oxygen, nitrogen, and phosphorus.

organophosphates: a group of pesticide chemicals containing phosphorus, such as malthion and parathion, intended to control insects. These compounds are short lived and, therefore, do not normally contaminate the environment.

outfall: the mouth of a sewer, drain, or conduit where an effluent is discharged into the receiving waters.

pathogenic: causing or capable of causing disease.

parameter: a measureable, variable quantity as distinct from a statistic or an estimate.

PCB's: Polychlorinated biphenyls, a group of organic compounds used in the manufacture of plastics. In the environment, PCB's exhibit many of the same characteristics as DDT, are highly toxic to aquatic life, persist in the environment for long periods of time, and are biologically accumulative.

pesticides: an agent used to control pests. This includes insecticides for use against harmful insects; herbicides for weed control; fungicides for control of plant disease; rodenticides for killing rats, mice, etc.; and germicides used in disinfection.

phosphorus: an element that, while essential to life contributes to the eutrophication of lakes and other bodies of water.

physical treatment operations: means of treatment in which the application of physical forces predominates. Screening, sedimentation, flotation, and filtration are examples. Physical treatment operations may or may not include chemical additions.

point source: any discernible, confined, and discrete conveyance from which pollutants are, or may be, discharged. Examples are sewage treatment plant outfalls, industrial waste outfalls, storm sewer outfalls, and boats.

pollutant: any gas, liquid, or solid whose nature, location, or quantity contaminates a medium (air, water, or soil)to a level of quality that is less desirable.

potable water: water suitable for drinking or cooking purposes from both health and aesthetic considerations.

pretreatment: any process used to reduce the pollution load of wastewater before primary treatment.

primary treatment: the first stage in wastewater treatment in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.

receiving waters: rivers, lakes, oceans, or other bodies that receive treated or untreated wastewaters.

residuals: leftovers--materials and energy that are no longer useful. When discharged into water, residuals may become pollutants.

reverse osmosis: an advanced method of waste treatment that relies on a semi-permeable membrane to separate waters from pollutants. When polluted water on one side of the membrane is placed under pressure, pure water will pass through to other side leaving pollutants behind.

river basin:	the total area drained by a river and its tributaries. Specifically, one of the large drainage areas specified as the basic units for water quality planning according to federal law.
runoff:	the portion of rainfall, melted snow or irrigation water that is not absorbed or retained but instead flows across ground surface and eventually is returned to streams. Runoff can pick up pollutants from the air or the land and carry them to the receiving waters.
salt water intrusion:	the invasion of salt water into a body of fresh water, occurring in either surface or groundwater bodies. When this invasion is caused by oceanic waters, it is called sea water intrusion.
secondary treatment:	wastewater treatment beyond the primary stage in which bacteria consume the organic parts of the wastes. This biochemical action is accomplished by use of trickling filters or the activated sludge process. Effective secondary treatment removes virtually all floating and settleable solids and approximately 90 percent of both BOD and suspended solids. If there are no provisions for advanced waste treatment, the sewage effluent is chlorinated at the end of secondary treatment.
sediment:	matter that has settled to the bottom of a liquid; or, more generally, all matter that has been eroded or washed from the land by water, regardless of whether it has settled.
sewage treatment plant:	any arrangement of equipment or structures for the treatment and disposal of sewage or wastewater.
sewage:	the total organic waste and wastewater generated by residential and commercial establishments. It is sometimes mixed with industrial waste.

sewerage:	the entire system of sewage collection, treatment, and disposal. Also applies to all effluent carried by sewers whether it is sanitary sewage, industrial wastes, or storm water runoff.
sludge:	the solid matter that settles to the bottom, floats, or becomes suspended in the sedimentation tanks and must be disposed of by filtration and incineration or by transport to appropriate disposal sites.
spoil:	mud, dirt, or rock that has been removed from its original location, specifically materials that have been dredged from the bottoms of waterways.
sporadic:	occurring in scattered single instances, infrequent.
stormwater:	water resulting from precipitation. Stormwater either percolates into the soil, runs off freely from the surface, or is captured by storm or combined sewers.
synergism:	the superimposed effects of separate pollutants or substances so that the total effect is greater than the sum of the effects independently.
thermal barrier:	an artificially created temperature elevation which prevents or adversely affects the passage or migration of fish or other aquatic life.
thermal pollution:	degradation of water quality by the introduction of a heated effluent.
total kjeldahl nitrogen: (TKN)	the sum of the nitrogen present in organic form plus that present in the form of ammonia. The TKN can be used to give an approximation of the oxygen demand due to the nitrogen in organic wastes.
toxic pollutants:	pollutants which upon exposure, ingestion, inhalation, or assimilation in any organism can cause death, disease, cancer, genetic mutations, physiological malfunctions or physical deformations.

trace metals:	trace metalic elements found in surface waters and sediments, the principal ones include: strontium, aluminum, boron, barium, and zinc.
turbidity:	a thick, cloudy condition in water due to the suspension of silt or finely divided organic matter. Turbidity blocks the transmission of light to aquatic plants, preventing them from producing the oxygen and food needed to support aquatic life and decompose wastes.
urban runoff:	storm water from city streets and gutters. Usually it contains a great deal of litter and organic and bacterial wastes.
wastewater:	water carrying wastes from homes, businesses, and industries that is a mixture of water and dissolved or suspended solids.
water quality:	a term used to describe the chemical, physical, and biological characteristics of water and often used in conjunction with an expression of its suitability for a particular use.
water quality standard:	the allowable levels of pollution for a given water use class. Water quality standards are based on known public health and environmental problems associated with pollution. Thus, they are subject to change as ecological science becomes more refined.
wetlands:	land-water edge areas, including submerged bottoms. Wetlands occur on a fringe along shoreline between the permanently dry land and the open waters and as extensive interim tracts of marsh or swamp.

ATTACHMENT 7-A
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (≥0.1 MGD)

STUDY AREA 1 -- BALTIMORE

Sub-Area B-1 (Upper Western Shore)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
Bainbridge Naval Testing Center	B-1	Cecil	U.S.	3.00	0.38	4	19	48	10	4	Susquehanna River
Port Deposit	B-2	Cecil	M	0.15	0.05	3	2.5	7.5	9	3	Susquehanna River
Rising Sun	B-3	Cecil	M	0.22	0.19	3	43	78	1,250	45	Stone Run, Susquehanna River
Havre De Grace	B-4	Harford	M	1.50	1.41	2	917	482	43	6	Chesapeake Bay
Aberdeen	B-5	Harford	M	1.13	1.41	4	412	447	222	30	Swan Creek, Chesapeake Bay
Aberdeen Proving Ground Poney	B-6	Harford	U.S.	0.50	0.42	4	63	76	1,315	151	Swan Creek, Chesapeake Bay
Aberdeen P. G. ORD T.C.	B-7	Harford	U.S.	2.80	1.21	4	71	131	106	7	Spesutie Narrows, Chesapeake Bay
Edgewood Arsenal Perryman	B-8	Harford	U.S.	3.00	1.32	4	38	127	17	7	Bush River, Chesapeake Bay
Sod Run, Perryman	B-9	Harford	CPW	4.20	3.83	4	511	607	212	22	Romney Creek, Chesapeake Bay
Hampstead	B-10	Carroll	SC	3.3	0.12	3	6	9	5	1	Piney Run, Gunpowder Falls
Manchester	B-11	Carroll	M	0.25	0.13	3	7	22	337	14	Georges Creek, Gunpowder Falls
Joppatown 1 & 2	B-12	Harford	PTIL	0.75	0.38	3	127	126	2,710	41	Little Gunpowder Falls
SUB-AREA B-1 TOTALS				17.8	11.85	--	185.3 (AVG)	179.7 (AVG)	131.7 (GM)	12.55 (GM)	

Sub-Area B-2 (Patapsco-Back River)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
Cox Creek	B-13	Anne Arundel	CPW	6.5	6.19	3	2,470	3,044	36,188	6,073	Patapsco
U.S. Coast Guard Curtis Creek	B-14	Anne Arundel	U.S.	0.56	0.88	2	70	35	93	55	Curtis Creek, Patapsco
Cooper Branch	B-15	Baltimore	CPW	0.6	0.36	4	53	62	60	8	Cooper Branch, Patapsco
Black & Decker Co.	B-16	Carroll	I	0.15	0.12	3	5	36	26	2	Hampstead, East Branch
Freedom Dist., [illegible]	B-17	Carroll	SC	1.6	N/A	3	N/A	N/A	N/A	N/A	South Branch, Patapsco
Mt. Airy	B-18	Carroll	M	0.3	0.12	3	13	23	9	3	South Branch, Patapsco
Springfield State Hospital	B-19	Carroll	S	0.75	0.35	4	155	61	68	13	Piney Run, South Branch, Patapsco
Back River	B-20	Baltimore City	M	175	160	4	181,748	55,876	6,836	1,276	Back River, Chesapeake Bay
Patapsco	B-21	Baltimore City	M	50	18	1	22,504	15,666	273	122	Patapsco
Holiday Mobile Estates	B-22	Anne Arundel	PR	0.18	0.03	3	1	6	167	36	Piney Run, Patapsco
SUB-AREA B-2 TOTALS				238.76	226.30	--	(AVG) 15,113	(AVG) 17,150	(GM) 156.8	(GM) 48.6	

Sub-Area B-3 (Patuxent-West Chesapeake)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
Annapolis	B-23	Anne Arundel	CPW	10.0	5.66	3	2,365	2,574	136	55	Whitehall Creek, Chesapeake Bay
Broad Creek, [illegible]	B-24	Anne Arundel	CPW	0.5	0.18	3	18	25	166	18	Broad Creek, Chesapeake Bay
[illegible]	B-25	Anne Arundel	CPW	4.8	0.62	3	32	136	66	3	Chesapeake Bay
[illegible]	B-26	Anne Arundel	CPW	1.0	0.15	3	1	9	3	2	Chesapeake Bay
Crownsville State Hospital	B-27	Anne Arundel	S	1.0	0.16	4	13	8	63	7	[illegible], South River, Chesapeake Bay
Severn River [illegible]	B-28	Anne Arundel	U.S.	0.5	0.33	4	38	133	46	3	[illegible] Creek, Severn River
[illegible]	B-29	Anne Arundel	CPW	0.15	0.66	3	1	5	58	6	[illegible] Creek, South River, Chesapeake Bay
[illegible]	B-30	Anne Arundel	CPW	2.25	2.12	2	55	446	188	18	South River, Chesapeake Bay
Chesapeake Beach	B-31	Calvert	M	0.15	0.11	3	50	150	63	8	Chesapeake Bay
North Beach	B-32	Calvert	M	0.3	0.66	[illegible]	78	56	987	14	Chesapeake Bay
Prince Frederick	B-33	Calvert	SC	0.15	0.08	3	3	6	4	1	[illegible] Creek, Chesapeake
Ft. Meade #1	B-34	Anne Arundel	U.S.	[illegible]	--	4	--	--	8	3	Little Patuxent River
Ft. Meade #2	B-35	Anne Arundel	U.S.	[illegible]	--	4	--	--	2	2	Little Patuxent River

ATTACHMENT 7-A (cont'd)
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (≥0.1 MGD)

STUDY AREA I -- BALTIMORE (cont'd)

Sub-Area B-3 (Patuxent-West Chesapeake)[1] (cont'd)

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
Maryland City	B-36	Anne Arundel	CWP	0.75	0.56	3	56	39	1,130	52	Patuxent River
Maryland House of Correction	B-37	Anne Arundel	S	0.75	0.49	3	267	414	16	7	Dorsey Run, Little Patuxent River
Patuxent	B-38	Anne Arundel	CWP	4.0	2.53	3	443	928	175	18	Little Patuxent River
Solomons Naval Ord.	B-39	Calvert	U.S.	0.2	0.07	4	6	10	4	2	Patuxent River
Johns Hopkins Lab, Scaggsville	B-40	Howard	I	0.16	0.06	4	6	14	6	2	Middle Patuxent River
Savage	B-41	Howard	CWP	3.0	3.33	3	667	1,022	181	33	Little Patuxent River
Andrews AFB	B-42	Prince Georges	U.S.	0.48	0.70	4	111	210	8	2	Cabin Branch, Patuxent River
Bel Air, Bowie	B-43	Prince Georges	M	2.65	2.43	4	446	446	13	2	Patuxent River
Bowie Race Track	B-44	Prince Georges	PC	0.105	0.08	3	30	28	0	0	Horsepen Branch, Patuxent River
Collington Pointer Ridge	B-45	Prince Georges	SC	0.9	0.37	1	96	241	3	3	Collington Branch, Patuxent River
Marlboro Meadows	B-46	Prince Georges	UCIL	0.6	0.16	3	21	20	18	1	Patuxent River
Marlton #1	B-47	Prince Georges	SC	0.3	0.3	3	70	60	4	2	Charles Branch, Patuxent River
Parkway	B-48	Prince Georges	SC	7.5	4.44	3	239	592	44	6	Patuxent River
Western Branch	B-49	Prince Georges	SC	8.0	7.33	3	377	628	6	1	Western Branch, Patuxent River
Cedars Point, Officers C.L.	B-50	St. Mary's	U.S.	0.168	N/A	4	N/A	N/A	623	200	Chesapeake Bay
Pine Hill Run, Lexington Park	B-51	St. Mary's	SC	3.0	1.65	4	176	206	63	4	Pine Hill Run, Chesapeake Bay
	SUB-AREA B-3 TOTALS			58.0	36.66	--	(AVG) 215.6	(AVG) 254.8	(GM) 25.9	(GM) 5.0	

STUDY AREA I, TOTAL DESIGN FLOW = 333.36 MGD; TOTAL AVG. FLOW = 272.23 MGD

STUDY AREA II -- POTOMAC

Sub-Area P-1 (Washington-Metro)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
Damascus	P-14	Montgomery	SC	0.76	0.03	3	3	4	1,331	114	Magruder Branch, Potomac River
Montgomery Village	P-15	Montgomery	SC	0.5	**	3	**	**	**	**	Cabin Creek, Potomac River
Naval Ord. Lab White Oak	P-16	Montgomery	U.S.	0.1	0.60	2	10	16	7	0	Paint Branch, Anacostia
NIH Animal Farm	P-17	Montgomery	U.S.	0.1	0.06	3	5	8	0	0	Broad Run, Potomac River
Poolesville	P-18	Montgomery	M	0.2	0.26	3	63	160	1,555	33	Dry Seneca Creek, Potomac River
Andrews AFB #1	P-19	Prince Georges	U.S.	0.543	1.16	4	160	150	1,520	650	Meeting House Branch, Piscataway Creek
Beltsville USDA Res. Ctr.	P-20	Prince Georges	U.S.	0.5	0.60	4	63	116	600	500	Beaver Dam Creek, Anacostia
Beltsville USDA Agricultural Res.	P-21	Prince Georges	U.S.	0.3	0.10	4	5	4	16	11	Little Paint Branch, Anacostia
Cheltenham Boys Village	P-22	Prince Georges	S	0.16	0.06	4	3	7	16	3	Piscataway Creek, Potomac River
Landover Mall	P-23	Prince Georges	SC	0.2	0.60	4	5	8	3	1	Beaver Dam Creek, Anacostia
Piscataway	P-24	Prince Georges	SC	30.0	15.62	4	366	690	6	1	Piscataway Creek Potomac River
Blue Plains[3]	P-25	District of Columbia	D C Dept. Environmental Services	300	270	4	122,500	57,600	--	--	Potomac River
	SUB-AREA P-1 TOTALS			344.59	302.15	--	(AVG) 9,336.5	(AVG) 8,541.6	(GM) 4.75	(GM) 15.[illegible]	

ATTACHMENT 7-A (cont'd)
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (≥0.1 MGD)

STUDY AREA II -- POTOMAC (cont'd)

Sub-Area P-2 (Lower Potomac)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	COLIFORM BACTERIA MPN PER 100 ml FECAL	RECEIVING WATERS
Indian Head	P-1	Charles	M	0.45	0.18	3	54	58	678	76	Mattawoman Creek, Potomac River
La Plata	P-2	Charles	M	0.3	0.19	4	32	31	564	30	Port Tobacco Creek, Potomac River
Mason Spring	P-3	Charles	SC	0.4	--	1	--	--	--	--	Mattawoman Creek, Potomac River
Mattawoman	P-4	Charles	SC	5.0	--	3	--	--	--	--	Mattawoman Creek, Potomac River
Naval Ord. Sta. #1 Indian Head	P-5	Charles	U.S.	0.35	--	3	--	--	313	200	Potomac River
Naval Ord. Sta. #2 Indian Head	P-6	Charles	U.S.	0.15	--	3	--	--	4	2	Mattawoman Creek, Potomac River
North Indian Head Estates	P-7	Charles	UTIL	0.16	0.08	1	22	29	53	4	Pomonkey Creek, Potomac River
Potomac Heights Clymont	P-8	Charles	PC	0.4	0.1	2	97	37	256	56	Potomac River
Southern Md. Corr. Cntr. Hughes	P-9	Charles	S	0.1	0.01	1	3	4	130,655	45,375	Gilbert Run, Wicomico River, Potomac River
Strawberry Hill Estates Marshall Hall	P-10	Charles	UTIL	0.1	0.05	3	2	4	136	6	Pomonkey Creek, Potomac River
Waldorf	P-11	Charles	SC	0.5	0.45	1	97	147	3,444	915	Mattawoman Creek, Potomac River
Leonardtown	P-12	St. Mary's	M	0.3	0.13	2	267	384	500	19	Town Run, Potomac River
Point Lookout State Park	P-13	St. Mary's	S	0.253	0.06	3	3	8	5	1	Chesapeake Bay
SUB-AREA P-2 TOTALS				8.663	1.53	--	(AVG) 65	(AVG) 80.2	(GM) 311.36	(GM) 40.55	

Sub-Area P-3 (Northern Virginia)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER**	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT	AVG. EFFLUENT LOADS BOD5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	RECEIVING WATERS
Leesburg	P-16	Loudoun	TOWN	1.30	1.60	Secondary	166	135	Tuscarora Creek
Purcellville	P-17	Loudoun	TOWN	0.25	0.30	Secondary	75	75	North Fork, Goose Creek
Manassas U.O.S.A.	P-18	Prince William	--	10.0	--	Advanced	--	--	Bull Run
Dumfries	P-19	Prince William	[illegible]	1.0	1.1	Secondary	663	335	Quantico Creek
[illegible]	P-20	Prince William	[illegible]	0.25	0.16	Secondary	33	37	Quantico Creek
Occoquan	P-21	Prince William	[illegible]	0.3	0.36	Secondary	23	58	Occoquan River
[illegible]	P-22	Prince William	[illegible]	1.0	1.1	Secondary	166	200	[illegible] Creek
[illegible]	P-23	Prince William	[illegible]	1.0	1.2	Secondary	200	318	[illegible] Creek
[illegible]	P-24	Prince William	[illegible]	1.15	0.8	Secondary	262	138	[illegible] Creek
Dale City I	P-25	Prince William	Dale Serv. Sa. Corp.	2.0	--	Advanced	--	--	[illegible] Creek
Dale City II	P-26	Prince William	Dale Serv. Sa. Corp.	2.0	--	Advanced	--	--	[illegible] Creek
Quantico	P-27	Prince William	U.S.M.C.	2.36	--	Secondary	--	--	Potomac River
Lorton	P-28	Fairfax	Washington, D.C.	0.76	0.6	Secondary	--	--	Mill Branch
Lower Potomac	P-30	Fairfax	Fairfax County	18.0	15.0	Secondary	--	--	Pohick Creek
Little Hunting Creek	P-40	Fairfax	Fairfax County	4.6	4.5	Secondary	--	--	Little Hunting Creek
Dogue Creek	P-41	Fairfax	Fairfax County	5.0	6.0	Secondary	--	--	Dogue Creek
Ft. Belvoir I	P-42	Fairfax	U.S. Gov't	2.5	--	Secondary	--	--	Potomac River
Ft. Belvoir II	P-43	Fairfax	U.S. Gov't	0.5	--	Primary	--	--	Potomac River

ATTACHMENT 7-A (cont'd)
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (≥0.1 MGD)

STUDY AREA II -- POTOMAC (cont'd)

Sub-Area P-3 (Northern Virginia)[3] (cont'd)

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNERSHIP	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	RECEIVING WATERS
Westgate	P-43	Fairfax	--	8.0	13.7	Secondary	--	--	Tributary to Potomac River
Herndon	P-44	Fairfax	TOWN	0.3	0.3	Secondary	--	--	Folly Lick Branch
Alexandria	P-45	Alexandria City	Alexandria Sanitary Authority	18.0	18.4	Secondary	--	--	Hunting Creek
Arlington	P-46	Arlington	Arlington County	26.0	21.5	Secondary	--	--	Four Mile Run
Pentagon	P-47	Arlington	U.S. Gov't	3.2	1.0	Secondary	--	--	Potomac River
Aquia Creek	P-48	Stafford	Aquia Cr. Sanitary District	0.5	0.45	Lagoon	--	--	Aquia Creek
Dahlgren	P-49	King George	Dahlgren Sanitary District	0.17	0.09	Lagoon	--	--	Williams Creek
Dahlgren Naval Weapons Lab	P-49	King George	--	0.37	0.35	Secondary	--	--	Potomac River
Colonial Beach	P-50	Westmoreland	TOWN	0.80	0.60	Primary	761	370	Monroe Bay
SUB-AREA P-3 TOTALS				111.90	85.26	--	(AVG) 232.66	(AVG) 204.88	

STUDY AREA II, TOTAL DESIGN FLOW = 463.08 MGD; TOTAL AVG. FLOW = 383.83 MGD

STUDY AREA III -- RAPPAHANNOCK-YORK

Sub-Area RY-1 (Rappahannock)[4]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNERSHIP	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	RECEIVING WATERS
Fredericksburg STP	R-4	City of Fredericksburg	City of Fredericksburg	3.5	2.635	Secondary	648.3	494.5	Rappahannock River
South Stafford Sanitary District - Claiborne Run STP	R-10	Stafford	So. Stafford San. Dist.	0.75	0.585	Secondary	84.0	140.0	Claiborne Run
So. Stafford San. Dist. - Ferry Farms STP ([illegible] Lagoon)	R-9	Stafford	So. Stafford San. Dist.	0.12	0.11	Secondary	66.8	67.0	Rappahannock River
Grafton Village STP	R-7	Stafford	--	0.136	--	Secondary	--	--	Tributary to Claiborne Run
Massaponax Regional STP	R-5	Spotsylvania	Rappahannock Service Authority	1.0	0.676	Secondary	180.7	193.3	Rappahannock River
Tappahannock Lagoon	R-1	Essex	Town of Tappahannock	0.3	0.16	Secondary	77.0	60.0	Hoskins Creek
Warsaw STP	R-2	Richmond	Town of Warsaw	0.22	--	Secondary	--	--	Tributary to Little Totuskey Creek
Urbanna STP	R-3	Middlesex	Town of Urbanna	Des: 0.65 Exist: 0.1	--	Secondary	--	--	Urbanna Creek
Kilmarnock STP	R-6	Lancaster	Town of Kilmarnock	0.1	--	Secondary	--	--	Tributary to Indian Creek
[illegible] STP	R-8	Northumberland	Town of [illegible]	0.1	--	--	--	--	Cockrell Creek
SUB-AREA RY-1 TOTALS				6.56	3.68	--	151.3 (AVG)	169.6 (AVG)	

Sub-Area RY-2 (York)[4]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNERSHIP	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
York & James City Co. [illegible]	Y-1	York	James City York County Sanitary District	0.430	[illegible]	Secondary	[illegible]	150	--	1,100	[illegible]
West Point STP	Y-2	King William	Town of West Point	[illegible]	[illegible]	Secondary	60	140	--	6	Mattaponi River
Gloucester STP	Y-3	Gloucester	Gloucester San. Dist. #1	0.15	0.133	Secondary	14.3	13.0	--	--	[illegible]
Mathews County [illegible] STP	Y-4	Mathews	Mathews County Sanitary Dist.	0.1	--	Secondary	--	--	--	--	[illegible] Creek
[illegible]	Y-5	Spotsylvania	Ni River Water & Sewer Co.	[illegible]	[illegible]	Primary	13	13	--	--	Ni River
Ashland STP	Y-6	Hanover	Town of Ashland	[illegible]	[illegible]	Primary	[illegible]	[illegible]	62	[illegible]	Unnamed tributary to Falling Cr. to [illegible] to Pamunkey
[illegible] STP	Y-7	[illegible]	City of [illegible]	1.00	[illegible]	Secondary	[illegible]	136	--	--	Little River, [illegible]
SUB-AREA RY-2 TOTALS				[illegible]	[illegible]	--	156	66.7	62	[illegible]	

STUDY AREA III, TOTAL DESIGN FLOW = [illegible] MGD; TOTAL AVG. FLOW = [illegible] MGD

ATTACHMENT 7-A (cont'd)
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (≥0.1 MGD)

STUDY AREA IV -- LOWER JAMES[3]

TREATMENT PLANT	PLANT I.D. NO.	COUNTY	OWNERSHIP	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT	AVG. EFFLUENT LOADS BOD5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	RECEIVING WATERS
Dam Neck	J-1	City of Virginia Beach	U.S.	--	.42	Secondary	--	--	Lake Rudee
Birchwood Gardens	J-2	City of Virginia Beach	County Utilities	.8	.36	Secondary	82	148	Lynnhaven
HRSD Oceana Naval Air Station	J-3	City of Virginia Beach	U.S. Navy	.3	.07	Secondary	211	145	Chesapeake Bay
HRSD Chesapeake-Elizabeth	J-4	City of Virginia Beach	U.S. Navy	8.0	11.24	Secondary	3,370	3,490	Chesapeake Bay
Colonial Heights W.P.C.P.	J-5	Chesterfield	Colonial Heights	1.0	1.72	Primary	1,200	1,250	Appomattox
City of Petersburg	J-6	Chesterfield	City of Petersburg	7.0	5.75	Primary	6,150	3,380	Appomattox
Byrd Airport	J-7	Henrico	City of Richmond	.8	.23	Secondary	33	71	Chickahominy
S.D. #2, Sandston	J-8	Henrico	Henrico County	.6	.67	Secondary	172	500	Chickahominy
S.D. #3, Highland Springs	J-9	Henrico	Henrico County	.5	.24	Secondary	103	300	Chickahominy
Glenwood Farms	J-10	Henrico	Henrico County	.15	.31	Secondary	86	250	Chickahominy
West End Manor	J-11	Henrico	West End Manor	.3	0.23	Secondary	103	300	Chickahominy
HRSD Army Base	J-12	Norfolk	HRSD Commission	11	13	Primary	17,500	5,200	Elizabeth
HRSD Lambert's Point	J-13	Norfolk	HRSD Commission	20	20.9	Primary	12,500	5,700	Elizabeth
HRSD Western Branch	J-14	City of Chesapeake	HRSD Commission	3	1.15	Primary	34,000	16,400	Elizabeth
City of Portsmouth	J-15	City of Portsmouth	City of Portsmouth	12	11.0	Primary	831	644	Elizabeth
Poplar Hill Subdivision	J-16	Norfolk	Tidewater Utilities	.32	.32	Secondary	11,600	9,120	Elizabeth
HRSD Deep Creek	J-17	City of Chesapeake	HRSD Commission	.67	.42	Secondary	110	320	Elizabeth
HRSD Washington	J-18	City of Chesapeake	HRSD Commission	.8	.07	Primary	87	129	Elizabeth
HRSD Great Bridge	J-19	City of Chesapeake	Chesapeake City	.25	.26	Primary	115	80	Elizabeth
Carolanne Farms	J-20	City of Virginia Beach	Kempsville Utilities	.36	.53	Secondary	153	117	Elizabeth
HRSD Boat Harbor	J-21	Newport News	HRSD Commission	33	19.56	Primary	20,400	11,560	James
HRSD James River	J-22	Newport News	HRSD Commission	5	5.19	Secondary	660	1,130	Warwick Bay
Town of Smithfield	J-23	Isle of Wight	Town of Smithfield	.3	.15	Secondary	158	110	James
U.S. Gov't Fort Eustis	J-24	Newport News	U.S.	2.55	1.58	Primary	3,350	1,650	James
HRSD Williamsburg Plant	J-25	James City	HRSD Commission	0.6	3.17	Secondary	652	663	James
City of Williamsburg	J-26	James City	City of Williamsburg	2.5	2.3	Secondary	683	363	James
Eastern State Hospital	J-27	James City	State	.50	.66	Secondary	230	460	James
Hopewell W.P.C.P.	J-28	Hopewell	City of Hopewell	3	2.73	Primary	6,640	3,430	James
Falling Creek W.P.C.P.	J-29	Chesterfield	Chesterfield County	3	6.32	Primary	5,160	3,100	James
City of Richmond W.P.C.P.	J-30	City of Richmond	City of Richmond	56	63	Primary	33,900	20,180	James
[illegible] Village	J-31	Henrico	Fairfield Service Corp.	.5	.5	Secondary	139	500	James
S.D. #5, Gillies Creek	J-32	Henrico	Henrico County	.5	.44	Secondary	64	145	James
Brighton Green	J-33	Chesterfield	Brighton Green	.42	.40	Primary	158	460	James
James River Estates	J-34	Chesterfield	City of Richmond	.56	.68	Primary	350	723	James
[illegible] W.P.C.P.	J-35	[illegible]	City of [illegible]	3	1.56	Secondary	1,555	647	[illegible] River
STUDY AREA IV TOTALS				163.91	166.70	--	[illegible] 6,155	[illegible] 2,733	

STUDY AREA IV, TOTAL DESIGN FLOW = 163.91; TOTAL AVG. FLOW = 166.70

ATTACHMENT 7-A (cont'd)
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (20.1 MGD)

STUDY AREA V -- LOWER EASTERN SHORE

Sub-Area LE-1 (Accomack-Northampton)[4]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT	AVG. EFFLUENT LOADS BOD_5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	RECEIVING WATERS
Machipongo Elem. School and Northampton Jr. H.S.	LE-11	Northampton	Northampton County School Board	.28	--	Secondary	8.3	8.3	Jacobus Creek
America House Motor Inn	LE-13	Northampton	Richmond Hotel, Inc.	.105	--	Secondary	2.0	2.0	Chesapeake Bay
Town of Onancock	LE-12	Accomack	Town of Onancock	.250	.49	Primary	325	350	Onancock Creek
Cape Charles Harbor	LE-17	Northampton	TOWN	--	0.2	NONE	400	400	Cape Charles, Chesapeake Bay
SUB-AREA LE-1 TOTALS				0.735	0.69	--	(AVG) 183.0	(AVG) 183.1	

Sub-Area LE-2 (Pocomoke)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD_5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	COLIFORM BACTERIA MPN PER 100 ml FECAL	RECEIVING WATERS
Crisfield	LE-1	Somerset	M	1.00	0.69	3	166	115	709	196	Little Annemessex, Tangier Sound
Princess Anne	LE-2	Somerset	SC	0.33	0.32	4	183	120	27	10	Manokin River, Tangier Sound
Snow Hill	LE-3	Worcester	M	0.50	0.40	3	470	256	18	5	Pocomoke
Pocomoke City	LE-10	Worcester	M	0.25 (incl. indus.	0.80	--	167	174	41	19	Pocomoke
SUB-AREA LE-2 TOTALS				10.1	2.24	--	(AVG) 243.5	(AVG) 237.5	(GM) 61.3	(GM) 20.7	

Sub-Area LE-3 (Nanticoke)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD_5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	COLIFORM BACTERIA MPN PER 100 ml FECAL	RECEIVING WATERS
Federalsburg	LE-4	Caroline	M	0.60	0.36	4	86	86	185	33	Marshy Hope Creek, Nanticoke River
Hurlock	LE-5	Dorchester	M	2.00	4.66	1	1,130	3,066	2	1	Wrights Branch, Marshy Hope, Nanticoke
Delmar	LE-6	Wicomico	M	0.30	0.27	4	65	47	4,685	146	Wood Creek, Wicomico River
Fruitland	LE-7	Wicomico	M	0.50	0.15	4	66	30	3	1	Wicomico River, Tangier Sound
Salisbury	LE-8	Wicomico	M	6.80	3.80	4	1,020	650.85	165	5	Wicomico River, Tangier Sound
Sharptown	LE-9	Wicomico	M	0.15	0.10	Secondary	18	9	181	33	Nanticoke
Bridgeville WWTP	LE-16	Sussex	M	0.5	0.61	Secondary	162	86	10	10	Bridgeville Branch, Nanticoke River
Seaford WWTP	LE-15	Sussex	M	0.9	0.9	Primary	870	365	150	20	Nanticoke
Laurel WWTP	LE-14	Sussex	M	0.35	.55	Secondary	135	521	173	20	Broad Creek, Nanticoke
SUB-AREA LE-3 TOTALS				12.0	11.27	--	(AVG) 345.3	(AVG) 545.3	(GM) 61.9	(GM) 10.2	

STUDY AREA V, TOTAL DESIGN FLOW = 23.66 MGD; TOTAL AVG. FLOW = 14.25 MGD

STUDY AREA VI -- UPPER EASTERN SHORE

Sub-Area UE-1 (Choptank)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD_5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	COLIFORM BACTERIA MPN PER 100 ml FECAL	RECEIVING WATERS
Denton	UE-1	Caroline	M	0.23	0.35	1	166	166	1,866	155	Choptank
Greensboro	UE-2	Caroline	M	0.18	0.13	4	32	18	1,780	50	Choptank
Ridgely	UE-3	Caroline	M	0.30	0.10	1	13	15	16	6	Tributary Choptank
Cambridge	UE-4	Dorchester	M	8.10	4.60	1	260	1,360	13	8	Choptank
Dorchester San. Dist. 3	UE-5	Dorchester	SC	0.16	0.18	1	118	130	117	5	Jenkins Creek, Choptank
Easton	UE-6	Talbot	M	2.00	1.61	1	110	130	60	0	Choptank
Oxford	UE-7	Talbot	M	0.112	0.60	1	30	33	18	8	Town Creek, Choptank
Preston	UE-10	Caroline	--	0.66	0.11	--	17	16	10,163	1,101	Choptank
SUB-AREA UE-1 TOTALS				10.113	6.60	--	(AVG) 175.6	(AVG) 181.8	(GM) 119.3	(GM) 22.9	

Sub-Area UE-2 (Chester)[1]

TREATMENT PLANT	PLATE I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD_5 (lb/dy)	AVG. EFFLUENT LOADS SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	COLIFORM BACTERIA MPN PER 100 ml FECAL	RECEIVING WATERS
Chestertown	UE-8	Kent	M	0.60	0.60	1	168.65	[illegible]	13	3	Radcliffe Creek, Chester River
Rock Hall	UE-9	Kent	M	0.15	0.11	1	6.61	45.87	4	1	Chester River, Chesapeake Bay
Centreville	UE-12	Queen Anne's	M	0.175	0.15	4	60.64	66.72	0	6	Corsica River, Chesapeake Bay
St. Michaels	UE-11	Talbot	M	0.50	0.15	1	68.57	112.98	11	8	Miles River, Eastern Bay
SUB-AREA UE-2 TOTALS				1.45	1.50	--	(AVG) [illegible]	(AVG) [illegible]	(GM) [illegible]	(GM) [illegible]	

ATTACHMENT 7-A (cont'd)
SEWAGE TREATMENT PLANTS WITHIN THE
CHESAPEAKE BAY STUDY AREA (≥0.1 MGD)

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-3 (Elk)[1]

TREATMENT PLANT	PLANT I.D. NO.	COUNTY	OWNER*	DESIGN FLOW (MGD)	AVG. ACT. FLOW (MGD)	DEGREE OF TREATMENT**	AVG. EFFLUENT LOADS BOD5 (lb/dy)	SS (lb/dy)	COLIFORM BACTERIA MPN PER 100 ml TOTAL	FECAL	RECEIVING WATERS
Charlestown	UE-12	Cecil	M	0.187	--	1	--	--	--	--	Northeast River
Elk Neck State Park	UE-13	Cecil	S	0.100	0.04	2	0.3	3	984	164	Elk River
Elkton	UE-14	Cecil	M	1.35	1.30	4	232	719	280	3	Big Elk Creek, Elk River
Holly Hall	UE-15	Cecil	M	0.40	0.17	3	11	30	9	1	Elk River
Northeast	UE-16	Cecil	CPW	0.30	0.32	2	324	136	11,950	3,017	Peddlers Creek, Northeast River
Perryville	UE-17	Cecil	M	0.720	0.43	3	110	221	775	22	Mill Creek, Chesapeake Bay
Triace-Elkton Industrial Park	UE-18	Cecil	PC	0.11	0.04	3	1	2	67	13	Little Elk Creek, Elk River
Betterton	UE-19	Kent	M	0.20	0.03	3	1	6	7,179	759	Chesapeake Bay
SUB-AREA UE-3 TOTALS				3.60	2.50	--	(AVG) 82.3	(AVG) 159.5	(GM) 685.7	(GM) 46.6	

STUDY AREA VI. TOTAL DESIGN FLOW = 21.14 MGD; TOTAL AVG. FLOW = 10.17 MGD

TOTAL CHESAPEAKE BAY STUDY AREA DESIGN FLOW = 1,000.55 MGD; AVG. FLOW = 852.84 MGD

FOOTNOTES:

[1]Data supplied by Maryland Department of Health and Mental Hygiene, Environmental Health Administration, Sewage Treatment Plant Summary Report, March 1975 - August 1975.

[2]Data supplied by District of Columbia Department of Environmental Services, Bureau of Wastewater Treatment, Report of Operations Fiscal Year 1975.

[3]Data supplied by Potomac-Shenandoah River Basin Report, Planning Bulletin [illegible], Virginia State Water Control Board.

[4]Data supplied by Virginia State Water Control Board.

[5]Data supplied by Lower James River Basin Comprehensive Water Quality Management Study, Planning Bulletin [illegible], Virginia State Water Control Board.

* OWNER CODES -- STATE OF MARYLAND:

F.G. -- Government

M -- Municipality

CPW -- County Public Works

C -- County

PRIV -- Private Facility

I -- Industrial

PC -- Private Corporation

SC -- Sanitary Commission

S -- State

** DEGREE OF TREATMENT CODES -- STATE OF MARYLAND:

1 -- Oxidation Lagoon

2 -- Septic Tank with or without Chlorinated Imhoff Tank

3 -- Activated Sludge

4 -- Trickling Filter

5 -- Advanced Waste Trt Plant (Nutrient Removal)

*** OWNER CODES -- STATE OF VIRGINIA:

OWSD -- Occoquan Watershed Sanitary District

UOSA -- Upper Occoquan Sewage Authority

SSSD -- South Stafford Sanitary District

HRSD -- Hampton Roads Sanitation District

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ATTACHMENT 7-B
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA I -- BALTIMORE

Sub-Area B-1 (Upper Western Shore)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
NONE			
	Sub-Area B-1 TOTAL	---	

Sub-Area B-2 (Patapsco-Back River)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Chesapeake Bay and Patapsco River	Anne Arundel Baltimore	11,640	Water quality conditions in Patapsco from runoff and industrial pollution
	Sub-Area B-2 TOTAL	11,640	

Sub-Area B-3 (Patuxent-West Chesapeake)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Severn River & Bay	Anne Arundel	4,636	Buffer zone-Annapolis Treatment Plant, Naval Command Treatment Plant, and Dreams Landing Treatment Plant
South River	Anne Arundel	1,795	Buffer zone for several sewage treatment facilities
West & Rhode	Anne Arundel	2,086	Buffer zone for treatment plant, storm water runoff
Herring Bay	Anne Arundel	2,203	Buffer zone for Rose Haven Sewage Treatment Plant
White Hall, Mill and Meredith Creeks	Anne Arundel	573	Storm water runoff from adjacent homes
Fishing Creek	Anne Arundel	1,025	Buffer zone for sewage treatment plants

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA I -- BALTIMORE (cont'd)

Sub-Area B-3 (Patuxent-West Chesapeake)[1] (cont'd)

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Mills, St. John's, & Back Creeks	Calvert	642	Buffer zone for marinas in Harbor
Patuxent River	Calvert, Charles St. Mary's	5,953	Erratic operation of sewage treatment plants upstream on the Patuxent
Battle Creek	Calvert	249	Malfunctioning septic system and storm runoff
Island Creek	Calvert	202	Malfunctioning septic system and storm runoff
	Sub-Area B-3 TOTAL	19,364	
	STUDY AREA I TOTAL	31,004 acres	

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA II -- POTOMAC

Sub-Area P-1 (Washington-Metro)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
NONE			
Sub-Area P-1 TOTAL		---	

Sub-Area P-2 (Lower Potomac)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Breton Bay	St. Mary's	1,109	Buffer zone for Leonardtown Sewage Treatment Plant and storm water runoff
St. Clement's Bay	St. Mary's	1,241	Storm water runoff of agriculture and animal origin
Canoe Neck Creek	St. Mary's	176	Stormwater runoff and sewage violation at individual homes
St. Patrick Creek	St. Mary's	197	Storm water runoff and sewage violation at individual homes
St. Catherine Sound	St. Mary's	181	Storm water runoff and sewage violations
St. Mary's River	St. Mary's	1,274	Buffer zone for St. Mary's College Sewage Treatment Plant
Neale Sound	Charles	301	Condition of shore line properties which will not permit satisfactory operation of septic tanks
Smith Creek	St. Mary's	860	Agricultural runoff and septic tank overflows.
Herring Creek	St. Mary's	469	Piney Pt. Elementary School and Shetland Acres Mobile Home Park Sewage overflows
Sub-Area P-2 TOTAL		5,808	

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA II -- POTOMAC (cont'd)

Sub-Area P-3 (Northern Virginia)[2]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Upper Machodoc Creek	King George	928	Sewage treatment plant buffer zone marinas
Monroe Bay, Monroe Creek, Mattox Creek	Westmoreland	1,508*	Buffer zone for treatment plant, marinas, and sub-division build-up
Sub-Area P-3 TOTAL		2,436	
* 730 condemned seasonal April 1 - November 14.			
STUDY AREA II TOTAL		8,244 acres	

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA III -- RAPPAHANNOCK-YORK

Sub-Area RY-1 (Rappahannock)[2]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Carter's Creek	Lancaster	590	Buffer zone-treatment plant, marina, industrial activity
Rappahannock River below Urbanna Creek and adjoining Wind Mill Point	Middlesex	1,248	Flow from Urbanna Creek, animal pollution, treatment plant at Christ Church School
Corrotoman River and Estuaries	Lancaster	350	Sewage discharge from town of Kilmarnock
Broad Creek	Middlesex	81	Marinas
Urbanna Creek	Middlesex	297	Treatment plant at town of Urbanna
Great Wicomico	Northumberland	798	Industrial pollution population build-up, boating activity
Dividing Creek	Northumberland	22	Animal pollution runoff from sheep and cattle farms
Dymers Creek	Lancaster	189	Industrial pollution, septic tank discharges
Indian Creek	Northumberland	255	Treatment plants
Sub-Area RY-1 TOTAL		3,830	

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA III -- RAPPAHANNOCK-YORK (cont'd)

Sub-Area RY-2 (York)[2]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
York River	---	8,517	Buffer zone for treatment plants, boating activity, and marina
Timberneck Creek	Gloucester	112	Animal pollution, boating activity, county solid wastes disposal
Sarah's Creek	Gloucester	305	Residential buildings, marinas, raw sewage
Horn Harbor	Mathews	42	Treatment plant, marina
Put-In Creek	Mathews	132	Treatment plant, septic tank overflows
Stutts Creek	Mathews	265	Treatment plant, residence discharge
Jackson Creek	Middlesex	200	-----
Sub-Area RY-2 TOTAL 9,573			
STUDY AREA III TOTAL 13,403 acres			

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA IV -- LOWER JAMES[2]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
James River adjacent to Fort Eustis	Newport News	3,392	Sewage treatment plants, shipping activities
Warwick River	Newport News	1,413	Sewage treatment plant, boating
Pagan River	Isle of Wight	1,748	Sewage treatment plant, marinas, meat processing plant
Bennetts Creek	City of Suffolk	170	Population build-up, people activity
Nansemond River	---	2,831	Sewage treatment plant, industrial pollution
Willoughby Bay	Newport News	1,205	Treatment plants, marinas, oil storage
Hampton Roads	Newport News	36,275	Treatment plants, oil storage, marinas, heavy boat activities
Back River	Newport News	1,178	Marinas
Little Creek	Virginia Beach	792	Marinas
Lynnhaven Bay	Virginia Beach	4,378	Treatment plants, marinas, residence septic tanks
Linkhorn Bay	Virginia Beach	794	Treatment plant
Chesapeake Bay	Virginia Beach and Norfolk	2,620	Marinas, commercial and military docks with heavy boat traffic, treatment plants
STUDY AREA IV TOTAL 56,796 acres			

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA V -- LOWER EASTERN SHORE

Sub-Area LE-1 (Accomack-Northampton)[2]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Cherrystone Creek	Accomack	264	Raw sewage discharged to waters, industrial pollution
Occohannock Creek	Accomack	272	Land runoff
Onancock Creek	Accomack	440	Sewage treatment plant, boating activity
Pocomoke Sound	Accomack	1,485	Raw sewage, industrial pollution
Oyster Harbor	Northampton	12	Industrial pollution, boating activity
Parting Creek and Willis Wharf	Northampton	192	Septic tank drainfield, boating activity
Tangier Island	Accomack	739	-----
Sub-Area LE-1 TOTAL		3,404	

Sub-Area LE-2 (Pocomoke)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Little Annemessex River	Somerset	1,989	Sewage treatment plant
Manokin River	Somerset	85	Treatment plant
Pocomoke Sound	Somerset	3,469	Land runoff
Sub-Area LE-2 TOTAL		5,543	

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA V -- LOWER EASTERN SHORE (cont'd)

Sub-Area LE-3 (Nanticoke)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Wicomico River	Wicomico Somerset	521	Treatment plant, storm water runoff
Nanticoke River	Dorchester Wicomico	3,253	Storm water runoff, treatment plants
Sub-Area LE-3 TOTAL 3,774			
STUDY AREA V TOTAL 12,721 acres			

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA VI -- UPPER EASTERN SHORE

Sub-Area UE-1 (Choptank)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
NONE			
STUDY AREA VI TOTAL --			

Sub-Area UE-2 (Chester)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Chester River	Kent, Queen Annes	4,642	Sewage treatment plant, storm water runoff
Reed and Grove Creeks	Queen Anne's	469	Storm water runoff, septic tanks overflowing
Corsica River	Queen Anne's	571	Treatment plant
Gray's Inn Creek	Kent	837	Overflowing septic systems
Langford Creek	Kent	531	Agriculture runoff, overflowing septic systems
St. Michaels Harbor	Talbot	61	Buffer zone -St. Michaels Treatment Plant
Kent Island Narrows	Queen Anne's	665	Waste from seafood processing plants
Queenstown Creek	Queen Anne's	316	Buffer zone-treatment plant
Cox Creek	Queen Anne's	142	Storm water runoff
Rock Hall Harbor	Kent	1,591	Storm water runoff, sewage violations
Spencer and Little Neck Creeks	Talbot	61	Storm water runoff, sewage violations
Oak Creek	Talbot	173	Storm water runoff, sewage violations
Leeds Creek	Talbot	387	Storm water runoff, sewage violations

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-2 (Chester)[1] (cont'd)

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Wye River	Queen Anne's Talbot	4,200	Storm water runoff of agriculture and animal origin
Sub-Area UE-2 TOTAL 14,646			

Sub-Area UE-3 (Elk)[1]

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
Town Creek	Talbot	102	Buffer zone - treatment plant
Choptank	Talbot Dorchester Caroline	12,252	Buffer zone - treatment plants
Back Creek	Dorchester	51	Sewage violations at individual homes on shoreline
Tilghman Island	Talbot	1,520	Sewage violations at numerous individual homes on island
San Domingo Creek	Talbot	908	Storm water runoff from the adjacent shores
Tred Avon River	Talbot	1,183	Buffer zone - treatment plant, storm water runoff
Island Creek	Talbot	822	Storm water runoff
Latrappe Creek	Talbot	428	Buffer zone - treatment plant
Little Choptank River	Dorchester	2,447	Sewage violations at individual homes
Sub-Area UE-3 TOTAL 19,713			
STUDY AREA VI TOTAL 34,359 acres			

ATTACHMENT 7-B (cont'd)
CLOSED SHELLFISH HARVESTING AREAS IN CHESAPEAKE BAY

CHESAPEAKE BAY MAINSTEM

AREA	COUNTY	ACREAGE	CONDITIONS FOR CLOSURE
MARYLAND[1]			
Chesapeake Beach	Calvert	2,384	Buffer zone-treatment plant
Chesapeake Bay at Cedar Point	St. Mary's	1,234	Buffer zone for Lexington Treatment Plant
Upper Chesapeake Bay	Anne Arundel Baltimore Kent	175,201	Storm water runoff, seasonal influx from major upstream rivers
	Maryland TOTAL	178,819	
VIRGINIA[2]			
Virginia Beach and Norfolk	---	2,620	Population density, marinas, oil refinery, treatment plants
Ball Creek	---	54	-----
Hampton Roads	---	1,100	-----
Tangier Island	---	739	-----
	Virginia TOTAL	4,513	
	MAINSTEM TOTAL	183,332 acres	

CHESAPEAKE BAY STUDY AREA TOTAL 339,859 acres

[1] Data supplied by Maryland Department of Natural Resources, November 1975.
[2] Data supplied by Virginia State Water Control Board, May 1971.

ATTACHMENT 7-B
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STATE OF MARYLAND[3]

STUDY AREA I -- BALTIMORE

Sub-Area B-1 (Upper Western Shore)

NONE

Sub-Area B-2 (Patapsco-Back River)

Patapsco Area, Anne Arundel and Baltimore Counties
All the area lying west of a line running from the west bank of the mouth of Shallow Creek to Rodkin Point and southeast of a line running from North Point to Rock Point.
Effective date: 12 September 1975

Sub-Area B-3 (Patuxent-West Chesapeake)

Severn River, Anne Arundel County
All the waters of the Severn River upstream of a line extending southerly from Greenbury Point to Greenbury Point Shoal Light south to Buoy No. 6, then to Buoy No. 4, and west to Tolly Point.
Effective date: 2 October 1975

Solomon Island Harbor, Calvert County
All of the waters of Back Creek, Mill Creek and St. John Creek upstream of a line extending from triangulation station Fishstack in a southerly direction to Solomon Island.
Effective date: 9 December 1964

South River, Anne Arundel County
All of the waters of the South River upstream of a line extending southerly from the large white house on Ferry Point to the red day marker 14A to a pier approximately 100 feet long on the end of Larrimore Point.

All of the waters of Glebe Bay, a tributary of the South River, upstream of a line extending from a pier approximately 100 feet long on the end of Larrimore Point to a duck blind off the entrance to the small pond inside Cedar Point.

All the waters of Duvall Creek upstream of Black Day Marker Number 1.

All the waters of Selby Bay south of a line extending in a southeast direction from Cupola to the Northwest gable on the yellow house.
Effective date: 6 December 1974

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA I -- BALTIMORE (cont'd)

Sub-Area B-3 (Patuxent-West Chesapeake) (cont'd)

Chesapeake Beach, Calvert County
All the waters of the Chesapeake Bay west of a line running in a southerly direction from Hog Point to Plum Point.
Effective date: 29 September 1964

Cedar Point Area, St. Mary's County
All the waters of the Chesapeake Bay within the boundaries of a line located 200 yards offshore and 1 mile either side of Pine Hill Run.
Effective date: 26 October 1964

Rhode and West Rivers, Anne Arundel County
All waters of the Rhode River upstream of a line extending from the north side of the mouth of Cadle Creek west to the northermost point of Locust Point.

All the waters of Cadle Creek upstream of a line extending from the north to south sides of the mouth of the creek.
Effective date: 16 September 1974

All that area of West River upstream of a line drawn from the most northern point to the entrance of Tenthouse Creek to a point on the opposite shore 700 feet northeast of triangulation station DAR.
Effective date: 3 April 1974

All that part of West River known as Parish Creek south of a line running from McKinly Point easterly to a point of land approximately 400 yards south of Curtis Point known as the mouth of Cedar Pond.
Effective date: 7 April 1967

Magothy River, Anne Arundel County

All the waters of the Magothy River and its tributaries upstream of a line running in a southerly direction from Chest Neck Point through Light 10 to the front chimney of a yellow house 1933.

All the waters of Forked Creek and Cool Spring Creek upstream of a line running in an easterly direction from the front chimney of a yellow house 1933 to a point at the mouth of Forked Creek (39°03.30' North Latitude, 76°29.15' West Longitude).

All the waters of Deep Creek upstream of a line running in a southeasterly direction from a point of land at Adams Point, (39°03.30' North Latitude, 76°27.19' West Longitude) to day marker 1 to the gable of a black roofed three story house.

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA I -- BALTIMORE (cont'd)

Sub-Area B-3 (Patuxent-West Chesapeake) (cont'd)

Magothy River, Anne Arundel County (cont'd)

All the waters of Cornfield Creek and James Pond upstream of a line running in an easterly direction from a point of land at Long Point (39°05.57' North Latitude, 76°26.41' West Longtitude) to the southeast point of the entrance to James Pond (39°05.58' North Latitude, 76°26.16' West Longitude).
Effective date: 24 April 1975

Herring Bay Area, Anne Arundel County

All the waters of Rockhold and Tracy Creeks upstream of a line extending from Leitch to triangulation station HOP.

All the waters of Herring Bay inside of a line extending from triangulation station "Hol" (Holland Point) north to DCBA Buoy, then northwest through Parker Island Shoal light to a point of land on Fairhaven Shore.
Effective date: 20 September 1973

Patuxent River, Calvert, Charles and St. Mary's Counties

All the waters of the Patuxent River west of a line running in a northeasterly direction from the east chimney of a brick house with three gables near the mouth of Trent Hall Creek to Day Mark 23 and northeasterly of a line running from Day Mark 23 to a point 1,050 yards south of Sandy Point (38°28.90' North Latitude, 76°38.90' West Longitude). Persommon and Washington Creeks remain closed.
Effective date: 5 May 1976

All the waters of Battle Creek and its tributaries upstream of a line extending eastward from the SW gable of a white barn on the west shore of Battle Creek to the south shore of the mouth of Horse Swim on the east shore of Battle Creek.

All the waters of Island Creek (Broome Island) upstream of a line extending from a bulkhead on the west shore of Island Creek east through Island Creek Light to a point of land on the east shore of Island Creek.
Effective date: 1 October 1974

Fishing Creek, Anne Arundel County

All waters of Fishing Creek upstream of a line extending northwest from Thomas Point to an unnamed point of land at Arundel on the Bay.
Effective date: 23 September 1974

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA I -- BALTIMORE (cont'd)

Sub-Area B-3 (Patuxent-West Chesapeake) (cont'd)

St. Jerome Creek, St. Mary's County
All the waters of Northern Prong, St. Jerome Creek, upstream of a line running from a point of land (38°07.07' North Latitude, 76°21.38' West Longitude) to a point of land (38°07.08' North Latitude, 76°21.21' West Longitude).
Effective date: 14 February 1975

STUDY AREA II -- POTOMAC

Sub-Area P-1 (Washington-Metro)

NONE

Sub-Area P-2 (Lower Potomac)

Breton Bay, St. Mary's County
All the waters of Breton Bay and its tributaries upstream of a line extending in a southeast direction from the northeast gable of the cottage nearest the point on the south shore of the mouth of Cherry Cove Creek to a pier approximately 3/4 miles below Lovers Point.
Effective date: 1 October 1974

St. Mary's River, St. Mary's County
All the waters of St. Mary's River upstream of a line running from Pagan Point to Church Point.
Effective date: 29 March 1976

St. George Creek, St. Mary's County
All the waters of St. George Creek excluding School House Branch and that portion of Locust Grove Cove upstream of a line extending from a point (38°09.87' North Latitude, 76°30.40 West Longitude).
Effective date: 23 January 1975

Neale Sound, Wicomico River, Charles County
All the waters of Neale Sound upstream of a line running in a northerly direction from Cobb Island through red entrance beacon 2 to Rock Point.
Effective date: August 1960

Smith Creek, St. Mary's County
All the waters of Smith Creek upstream of a line running in an easterly direction from a point of land (38°08.09' North Latitude, 76°25.09' West Longitude) to a point of land (38°08.09' North Latitude, 76°24.85' West Longitude).
Effective date: 24 April 1976

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA II - POTOMAC (cont'd)

Sub-Area P-2 (Lower Potomac) (cont'd)

Herring Creek, St. Mary's County
All the waters of Herring Creek south of a line running in a westerly direction from the southwest gable of a long barn with a tin roof to Daymarker 4 near the mouth of Herring Creek and north of a line running in a northeasterly direction from a point of land (38°10.87' North Latitude, 76°31.93' West Longitude) to a point of land (38°10.92' North Latitude, 76°31.78' West Longitude) then northeasterly to a point of land (38°10.99' North Latitude, 76°31.67' West Longitude).
Effective date: 27 March 1976

Wicomico River, Charles and St. Mary's County
All the waters of the Wicomico River upstream of a line extending south from Luckton Point to Barber Point with the exception of Dolly Boarmans Creek and Chaptico Bay.

All waters of Dolly Boarmans Creek upstream of a line from the farthest point of land on the north shore at the mouth of the creek to a point directly opposite on the south shore of the creek.

All waters of the Chaptico Bay upstream of a line extending from Cohouck Point south to a pier located approximately 950 yards east of Mills Point.
Effective date: 16 October 1974

Saint Catherine Sound, St. Mary's County
All waters of White Neck Creek upstream of a line from a point on the western shore of White Neck Creek described as North Latitude 38°15' and West Longitude 76°48' extending east to a point on the eastern shore described as North Latitude 38°14'45" and West Longitude 76°47'15".
Effective date: 1 October 1974

Charleston Creek, Charles County
All the waters of Charleston Creek lying west of a line running in a northernly direction from Persimmon Point to Fennell Point and east of a line running in a northwesterly direction from a point of land (38°17.50' North Latitude, 76°51.00' West Longitude) to a point of land (38°17.60' North Latitude, 76°51.10' West Longitude).
Effective date: 2 September 1975

St. Clement Bay, St. Mary's County
All the waters of St. Clement Bay upstream of a line extending east from the southern shore of the mouth of Miley Creek to a triangular marker on the opposite shore.
Effective date: 25 March 1975

STUDY AREA II -- POTOMAC (cont'd)

Sub-Area P-2 (Lower Potomac) (cont'd)

St. Patrick Creek, St. Mary's County

All the waters of St. Patrick Creek upstream of a line running in a northerly direction from a point of land (38°14.11' North Latitude, 76°45.30' West Longitude) to a fence (38°14.18' North Latitude, 76°45.32' West Longitude). Back Creek remains closed.
Effective date: 15 March 1976

Restricted Area for Piney Point Sewage Treatment Plant Discharge, St. Mary's County

All the waters of the Potomac River inside a line running in a southerly direction from the L-Shaped Pier at Piney Point Beach (38°08.46' North Latitude, 76°31.13' West Longtitude) to the second dolphin offshore (38°08.31' North Latitude, 76°31.12' West Longtitude); then in a southwesterly direction to St. George Creek West Channel Light 1; then in a northwesterly direction to the north end of the St. George Island Bridge.
Effective date: 15 September 1975

STUDY AREA V -- LOWER EASTERN SHORE

Sub-Area LE-2 (Pocomoke)

Manokin River, Somerset County

All of the waters of Manokin River, Kings Creek and their tributaries easterly of the confluence on Manokin River and Kings Creek.
Effective date: 16 January 1967

Pocomoke Sound

All the waters of the Pocomoke Sound in Maryland upstream of a line running in a northerly direction from triangulation station SHAD (VFC 1936) on the Virginia shore to Light 10 in Fair Island Canal with the exception of the waters of Marumsco Creek upstream of a line running in a northeasterly direction from the south gable of the green clubhouse on Rumbly Point to a point of land (37°58.65' North Latitude, 75°42.90' West Longitude) on the opposite shore.
Effective date: 27 October 1975

All of the Maryland waters of the Pocomoke River and its tributaries upstream of Day Beacon "14".
Effective date: 20 September 1973

Little Annemessex River, Somerset County

All the waters of the Little Annemessex River upstream of a line running from Great Point to Long Point.
Effective date: 21 May 1942

STUDY AREA V -- LOWER EASTERN SHORE (cont'd)

Sub-Area LE-3 (Nanticoke)

Wicomico River, Wicomico County
All the waters of the Wicomico River and its tributaries upstream of a line extending from Pine Beach Clubhouse, in a northerly direction through Wicomico River Day Beacon No. 19 to a point of land on the Wicomico Shore.
Effective date: 23 September 1974

Nanticoke River, Dorchester and Wicomico Counties
All the waters of the Nanticoke River and its tributaries upsteeam of a line drawn from a point on the Dorchester County shore 900 yards north from the mouth of Langrells Creek to the west gable of the Red House located 1,400 yards south of Hatcrown Point on the Wicomico Shore.
Effective date: 23 September 1974

Monie Bay, Somerset County
All the waters of Monie Bay upstream of a line running from Department of Natural Resources survey marker Clin located on the north shore near Monie Point to a point on the southern shore 1,400 ft. southwesterly of United States Coast and Geodetic Survey Monument Monie 2.
Effective date: 9 April 1975

STUDY AREA VI -- UPPER EASTERN SHORE

Sub-Area UE-1 (Choptank)

Choptank River, Talbot County, Dorchester County
All the waters of the Choptank River upstream of a line extending from the southwest bank of Porpoise Cove, Talbot County side, west to the end of the white stone revetment, on the northwest corner of the unnamed cove located at the Du Pont Estate, University of Maryland, Dorchester County. Porpoise Cove is to remain closed.
Effective date: 21 October 1974

Back Creek, Dorchester County
All that part of Back Creek, Upper Hooper Island, inside a line drawn from Ben Point in a northeasterly direction to Old House Point.
Effective date: 21 May 1942

San Domingo Creek, Talbot County
All of that part of San Domingo Creek and adjacent tributary waters east of a line extending from Triangulation Station "Ansley" northerly to Triangulation Station "Samuel" and north of a line extending due west from Triangulation Station "Samuel" to a point on the western shore of San Domingo Creek.
Effective date: 19 July 1951

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-1 (Choptank) (cont'd)

Tilghman Island, Talbot County

A line starting at Amy's Marsh Point and proceeding in a southerly direction to a point 300 yards offshore from mean high water mark at triangulation station "Hays"; thence to a point 300 yards offshore from mean high water mark at Fairbank; thence to a point 300 yards offshore from mean high water mark at Radar Tower; thence to Black Walnut Point; thence northeast to a point 300 yards east of Lower Bar Neck Point; thence in a northerly direction to Middle Ground Bar light; thence to Knapps Narrows east entrance light; and then in a northerly direction to point on land in line with the vent on barn as shown on Department of Chesapeake Bay Affairs chart number eleven (11) of Natural Oyster Bars.
Effective date: 16 March 1970

Tred Avon River, Talbot County

All waters of Tred Avon River and its tributaries upstream of a line extending from Long Point in a southeast direction to an unnamed cove on opposite shore.

All waters of Town Creek inside a line from point of land 1/3 mile southwest of triangulation station "Town" to end of Seth Street in the town of Oxford.

All the waters of Goldsborough Creek upstream of a line extending from shore to shore at mouth along southeast border of Louis Cove addition oyster bar.
Effective date: 16 September 1974

Island Creek, Talbot County

All the waters of Island Creek upstream of a line from the chimney of a gray house with a black roof on the north bank of Island Creek to the chimney, west gable of a white house on the south bank of Island Creek and downstream of a line running in a southwesterly direction from a point of land (38°40.35' North Latitude, 76°07.10' West Longitude) to a point of land (48°40.20' North Latitude, 76°07.03' West Longitude).
Effective date: 10 February 1976

La Trappe Creek, Talbot County

All the waters of La Trappe Creek upstream of a line from Trappe Point to Grubin Point.
Effective date: August 1960

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-1 (Choptank) (cont'd)

Little Choptank River, Dorchester County

All the waters of the Little Choptank River north of a line running from a point of land on the east side of the mouth of Beckwith Creek (38°33.30' North Latitude, 76°13.35' West Longitude) to a point of land on the west side of the mouth of Beckwith Creek (38°33.42 North Latitude, 76°12.77' West Longitude), east of a line running from a point of land on the north side of the Little Choptank (38°33.50' North Latitude, 76°12.30' West Longitude) to a point of land on the south side of the Little Choptank (38°33.25' North Latitude, 76°12.07' West Longitude) and south of a line running from McKeil Point through Fishing Creek Day Marker 2 to the brick chimney of the east gable of a 2 story house on Town Point.
Effective date: 25 August 1975

All the waters of Hudson Creek upstream of a line extending from the chimney NE gable of the white house with the black roof on the west bank of Hudson Creek to the west gable of a house located opposite on the east bank of Hudson Creek.
Effective date: 16 September 1974

Sub-Area UE-2 (Chester)

Chester River, Queen Anne and Kent County

All the waters of the Chester River upstream of a line running from Quaker Neck Landing to Ashland Landing and downstream of a line from Northwest Point to the south side of the mouth of Browne Creek.
Effective date: 15 September 1973

Grays Inn Creek, Kent County

All the waters of Grays Inn Creek and its tributaries upstream of a line extending from Little Gum Point to Grays Inn Point.
Effective date: 20 September 1973

Langford Creek, Kent County

All the waters of Langford Creek and its tributaries upstream of a line extending from Long Point in a southeast direction to a point of land approximately 500 yards north of Nichols Point.
Effective date: 16 January 1973

Corsica River, Queen Anne's County

All the waters of the Corsica River upstream of a line running from triangular marker Ship on the northern shore of the Corisca River to triangular marker Bath on the southern shore.
Effective date: 21 May 1942

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-2 (Chester) (cont'd)

Reed and Grove Creeks, Queen Anne's County

All the waters of Reed and Grove Creeks upstream of a line extending from Gordon Point in a northeast direction to a point of land at the east entrance to Grove Creek.
Effective date: 20 September 1973

St. Michael's Harbor, Talbot County

All that part of St. Michael's Harbor inside a line drawn from Parrots Point in a northwesterly direction to Cedar Point.
Effective date: 21 May 1942

Kent Narrows, Queen Anne's County

All waters of Muddy Creek within 100 feet of shoreline as indicated on August 1963, Map 14.

All waters of Kent Narrows between a line, extending from a point of land on western shore due east through Black Buoy No. 9 to a point of land on eastern shore, Prospect Bay side; and a line extending from triangulation station THIN in a southeast direction along north boundary of Flood Point Bar to point of land at west entrance to Muddy Creek, Chester River side.

All waters of Wells Cove and Marshy Creek east of a line extending from north entrance to Wells Cove in southeast direction to southern entrance along northeast border of Wells Cove Bar, then continuing along northeast boundary of bar to point of land on south shore of Marshy Creek.
Effective date: 20 September 1973

Queenstown Creek, Queen Anne's County

All the waters of Queenstown Creek upstream of a line from Courcy Point to Blakeford Point.
Effective date: August 1960

Cox and Thompson Creeks, Queen Anne County

All waters of Cox Creek and its tributaries upstream of the line indicated on attached map.

All waters of Thompson Creek and tributaries upstream of a line extending from triangulation station "Steve" (South Bank) in northeast direction to a point of land on north shore at entrance to creek.
Effective date: 20 September 1973

Rock Hall Harbor, Kent County

All the waters of the Chesapeake Bay, Rock Hall Harbor, Tavern Creek, Swan Creek, and Huntingfield Creek upstream of a line from Swan Point to Huntingfield Point.
Effective date: September 1964

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-2 (Chester) (cont'd)

Miles River, Talbot County
All waters of the Miles River upstream of a line from the southwest gable of the white house on the east bank of the Miles River to the fartherest point of land on the south side of an unidentified cove on the west bank of the Miles River.

All the waters of Hunting Creek lying upstream of a line from a triangular marker on the north side of Long Point to the fartherest point of land at Ingleton. Little Neck and Spencer Creeks remain closed.
Effective date: 16 September 1974

Oak Creek, Talbot County
All of that part of Miles River which is south of a line drawn from the south bank of Newcomb Creek in a southwesterly direction to a point of land, which is approximately 700 yards from the west end of the Oak Creek bridge.
Effective date: 10 March 1969

Leeds Creek, Talbot County
All of the waters of Leeds Creek, a tributary of Miles River, upstream from a line drawn from Fairview Point in a southeasterly direction to a point of land on the opposite shore marked by a Health Department sign.
Effective date: 27 September 1969

Lowe's Creek, Talbot County
All the waters of Lowe's Creek upstream of a line running from a point of land on the west bank of the mouth of Lowe's Creek (38°49.99' North Latitude, 76°15.50' West Longtitude) to a point of land on the east bank (38°49.98' North Latitude, 76°15.48' West Longitude).
Effective date: 4 August 1975

Wye River, Queen Anne's and Talbot Counties
All the waters of the Wye River upstream of a line running in a northwesterly direction from the triangulation station June (MSFC) 1909 near Grapevine Point to the east chimney of a white house on the opposite shore.
Effective date: 19 January 1976

All the waters of the Wye River adjacent to the Wye Landing County Wharf and upstream of a line running in an easternly direction from a point of land (38°53.30' North Latitude, 76°11.37' West Longitude) to a point of land (38°53.30' North Latitude, 76°11.20' West Longitude) on opposite shore.
Effective date: 19 January 1976

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

STUDY AREA VI -- UPPER EASTERN SHORE (cont'd)

Sub-Area UE-2 (Chester) (cont'd)

Wye River, Queen Anne's and Talbot Counties (cont'd)
All the waters of the Wye East River and its tributaries upstream of a line extending from Whetstone to Red Nun 2, (38°51.85' North Latitude, 76°10.75' West Longitude), to a point of land (38°51.60' North Latitude, 76°10.61' West Longitude).
Effective date: 24 July 1975

Crab Alley and Little Creeks, Queen Anne's County
All the waters of Crab Alley and Little Creeks upstream of a line running from the most southeastern point of land (38°56.10' North Latitude, 76°17.08' West Longitude) at the mouth of Little Creek to a point of land on the east side of Johnson Island (38°55.95' North Latitude, 76°17.30' West Longitude).

All the waters of Crab Alley Creek upstream of a line running from a pier on the west side of Johnson Island through Crab Alley Bay Day Beacon 7 to a point of land on the west shore of Cox Neck (38°56.78' North Latitude, 76°17.76' West Longitude).
Effective date: 23 May 1975

Shipping Creek, Queen Anne's County
All the waters of Shipping Creek and its tributaries upstream of a line running in a southeasterly direction from a point of land (38°54.77' North Latitude, 76°20.59' West Longitude) to a point of land (38°54.66' North Latitude, 76°20.44' West Longitude).
Effective date: 20 June 1975

Piney Creek, Queen Anne's County
All the waters of Piney Creek south of a line running in a southeasterly direction from a point of land (38°59.02' North Latitude, 76°15.53' West Longitude) on the west shore to a point of land (38°58.92' North Latitude, 76°14.92' West Longitude) on the east shore.
Effective date: 30 September 1975

Sub-Area UE-3 (Elk)

NONE

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
MARCH 31, 1976

CHESAPEAKE BAY MAINSTEM

Upper Chesapeake Bay
All the area north of a line running in a southeasterly direction from the Robins Point Tower to the northermost point on Pooles Island and then easterly to the Worton Point Tower.
Effective date: 13 April 1976

Chesapeake Bay, Anne Arundel County
All the area of the Chesapeake Bay inside of a line running from the bulkhead at Podickery Yacht Basin to Buoy A to Buoy C to Sandy Point Lighthouse to Buoy D to the lone cedar tree at Sandy Point.

All the area of the Chesapeake Bay and its tributaries inside a line running from the lone cedar tree at Sandy Point to Buoy F to Buoy G to Buoy H to Buoy J to Buoy K to Buoy M to Buoy N to Buoy P to Buoy Q to Buoy R to Greenbury Point Light to Radio Tower 9 near Greenburg Point.

All the area of the Chesapeake Bay inside of a line from Tolly Point triangulation station B73 (1942) to Buoy T to Buoy S to Buoy U to Buoy V to Buoy W to Buoy X to Buoy Y to Thomas Point Shoal Lighthouse 1906 to Buoy AA to Buoy BB to Buoy CC to Buoy DD to Buoy EE to Buoy FF to Buoy GG to a point of land directly opposite.

All the area of the Chesapeake Bay and its tributaries inside of a line running from the Monument Turkey 1974 (MGS) at Turkey Point to Black Can Buoy 7 to Buoy HH to Buoy JJ to the northwest corner of a duckblind to the wreck daymark to Buoy LL to West River Light 2 to Rhode River Light 2 to the white cupola on Dutchman Point.
Effective date: 19 November 1975

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[3]Updated data supplied by Maryland Department of Natural Resources, May 1976.

ATTACHMENT 7-B
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
FEBRUARY 1, 1976

STATE OF VIRGINIA[4]

STUDY AREA II -- POTOMAC

Sub-Area P-3 (Northern Virginia)

AREA	ACREAGE
South Yeocomico River	366
Nomini & Currioman Bays	670
Rosier Creek	233
Hunting & Deep Creeks	305
Potomac River tributaries	13,343
Coan River & The Glebe Lake	321
Sub-Area P-3 TOTAL	15,238
STUDY AREA II TOTAL	15,238 acres

STUDY AREA III -- RAPPAHANNOCK-YORK

Sub-Area RY-1 (Rappahannock)

AREA	ACREAGE
Upper Rappahannock River to Port Royal	20,472
Upper Piankatank River	1,328
Greenvale Creek	92
Sturgeon Creek	99
Bush Park Creek	60
Paynes Creek	28
Beach Creek	45

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
FEBRUARY 1, 1976

STUDY AREA III -- RAPPAHANNOCK-YORK (cont'd)

Sub-Area RY-1 (Rappahannock) (cont'd)

AREA	ACREAGE
Lancaster Creek	229
Great Wicomico River	319
Piankatank River, Wilton Creek	43
Healy Creek	26
Totuskey & Richardson Creeks	740
Lagrange Creek	409
Western Branch Corrotoman River	184
Farnham Creek	263
Tabbs Creek	22
Sub-Area RY-1 TOTAL	24,359

Sub-Area RY-2 (York)

AREA	ACREAGE
Fox Creek	15
Ware Creek	67
Aberdeen Creek	73
Carter Creek	22
Skimino Creek	44
Northshore Carter Creek	98
Cedarbush Creek	137
Jones Creek	44

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
FEBRUARY 1, 1976

STUDY AREA III -- RAPPAHANNOCK-YORK (cont'd)

Sub-Area RY-2 (York) (cont'd)

AREA	ACREAGE
King & Felgates Creeks	344
Ware River	283
Wilson Creek	94
Back Creek	225
Queens Creek	282
Poropotank Bay & Adams Creek	754
East River	170
Sub-Area RY-2 TOTAL	2,652
STUDY AREA III TOTAL	27,011 acres

STUDY AREA IV -- LOWER JAMES

AREA	ACREAGE
Willoughby Bay	1,205
James River opposite Tribell Shoal Channel	1,318
Upper James to Hopewell Airport	54,082
Nansemond River, Knotts Creek	90
Chuckatuck Creek	466
James River adjacent Lake Maury	1,158
Poquoson River, Chisman & Patricks Creeks	923
Middle Warwick River	710
Davis Creek	43
STUDY AREA IV TOTAL	59,995 acres

ATTACHMENT 7-B (cont'd)
UPDATED DESCRIPTION OF CLOSED SHELLFISH WATERS
FEBRUARY 1, 1976

STUDY AREA V -- LOWER EASTERN SHORE

Sub-Area LE-1 (Accomack-Northampton)

AREA	ACREAGE
Warehouse Creek	78
Chesconessex Creek	41
Nassawadox Creek	95
Pungoteague Creek	309
Jacobus Creek	252
Swans Gut Creek	78
Parker Creek	76
Jacobus & Mattawoman Creeks	252
Cherrystone Inlet	121
Sub-Area LE-1 TOTAL	1,302
STUDY AREA V TOTAL	1,302 acres

CHESAPEAKE BAY UPDATED TOTAL SHELLFISH CLOSURES 103,546 acres

[a]Updated data supplied by Virginia State Department of Health, Bureau of Shellfish Sanitation, March 1976.

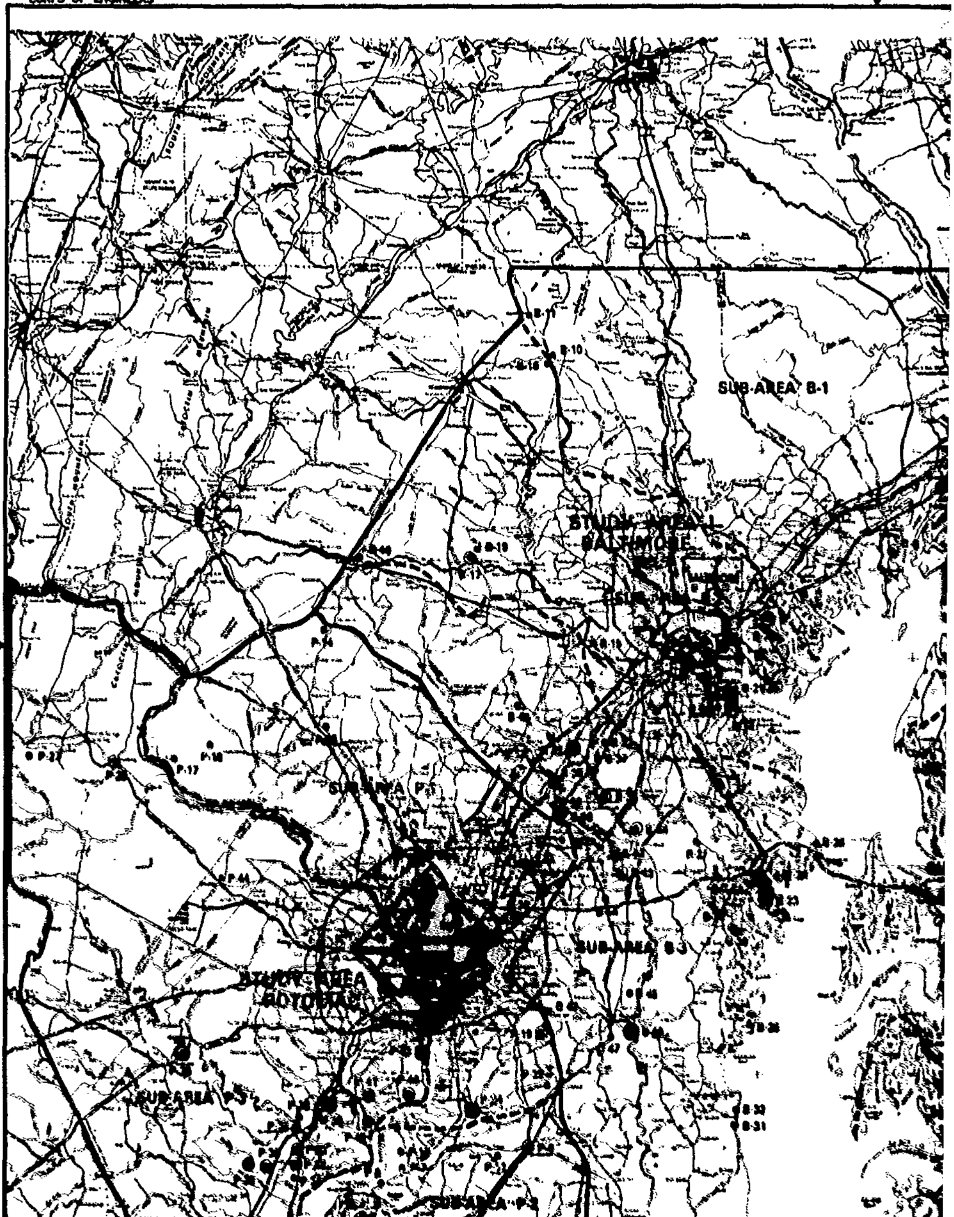
ATTACHMENT 7-B
CLOSED SHELLFISH AREAS IN THE CHESAPEAKE BAY AREA

LOCATION	ACREAGE[1,2]	UPDATED ACREAGE[3,4]	CONDITIONS FOR CLOSURE
Study Area I - Baltimore	31,004	—	Buffer zone treatment plants Industrial pollution Stormwater runoff Boating activity
Study Area II - Washington Metro	8,244	15,238	Buffer zone treatment plants Stormwater runoff Marinas Subdivision build-up
Study Area III - Rappahannock-York	13,403	27,011	Buffer zone treatment plants Marinas Stormwater runoff Septic tank discharges
Study Area IV - James	56,796	59,995	Buffer zone treatment plants Heavy boat activities Marinas Population build-up
Study Area V - Lower Eastern Shore	12,721	1,302	Buffer zone treatment plants Boating activity Septic tanks Land runoff
Study Area VI - Upper Eastern Shore	34,359	—	Buffer zone treatment plants Stormwater runoff Septic tanks Boating activity
Chesapeake Bay	183,332	—	Buffer zone treatment plants Stormwater runoff Seasonal influx from major upstream rivers
STUDY AREA TOTALS	339,859	103,546	

TOTAL CLOSURES IN CHESAPEAKE BAY = 443,405 acres

[1]Data supplied by Maryland Department of Natural Resources, November 1975.
[2]Data supplied by Virginia State Water Control Board, May 1971.
[3]Updated data supplied by Maryland Department of Natural Resources, May 1976.
[4]Updated data supplied by Virginia State Department of Health, Bureau of Shellfish Sanitation, March 1976.

CORPS OF ENGINEERS



2

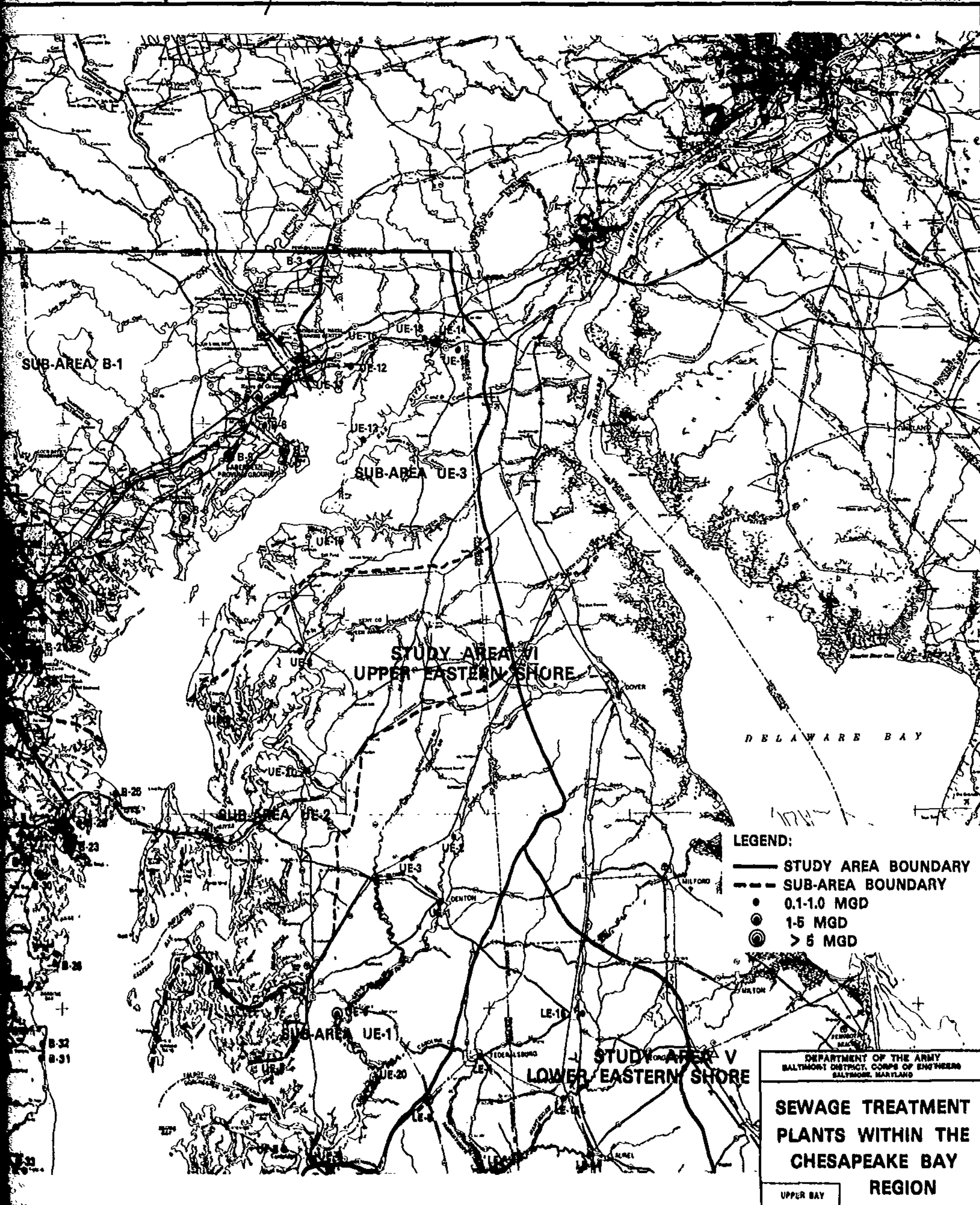
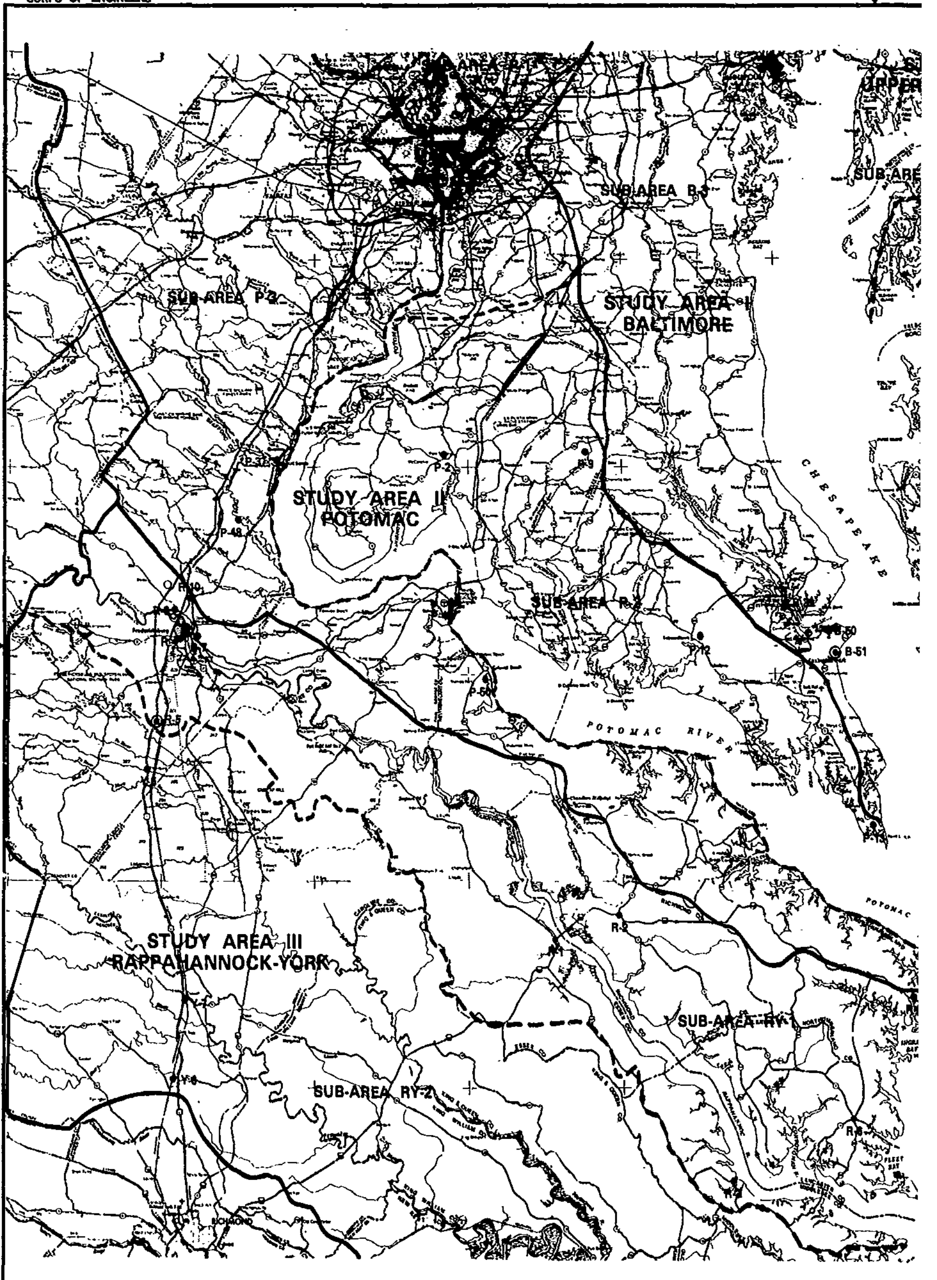

SUB-AREA B-1
SUB-AREA UE-3
STUDY AREA VI
UPPER EASTERN SHORE
SUB-AREA UE-2
SUB-AREA UE-1
STUDY AREA V
LOWER EASTERN SHORE
DELAWARE BAY
DOVER
MILFORD
DENTON
MILTON
FEDERALSBURG
B-3
B-26
B-23
B-32
B-31
UE-12
UE-13
UE-19
UE-20
UE-3
LE-10
LEGEND:
STUDY AREA BOUNDARY
SUB-AREA BOUNDARY
0.1-1.0 MGD
1-5 MGD
> 5 MGD
DEPARTMENT OF THE ARMY
SEWAGE TREATMENT
PLANTS WITHIN THE
CHESAPEAKE BAY
REGION
UPPER BAY

PLATE 7-1


SUB-AREA B-3
STUDY AREA I
BALTIMORE
SUB-AREA P-3
STUDY AREA II
POTOMAC
SUB-AREA R-2
CHESAPEAKE
POTOMAC RIVER
STUDY AREA III
RAPPAHANNOCK-YORK
SUB-AREA RY-1
SUB-AREA RY-2
B-51

U. S. ARMY

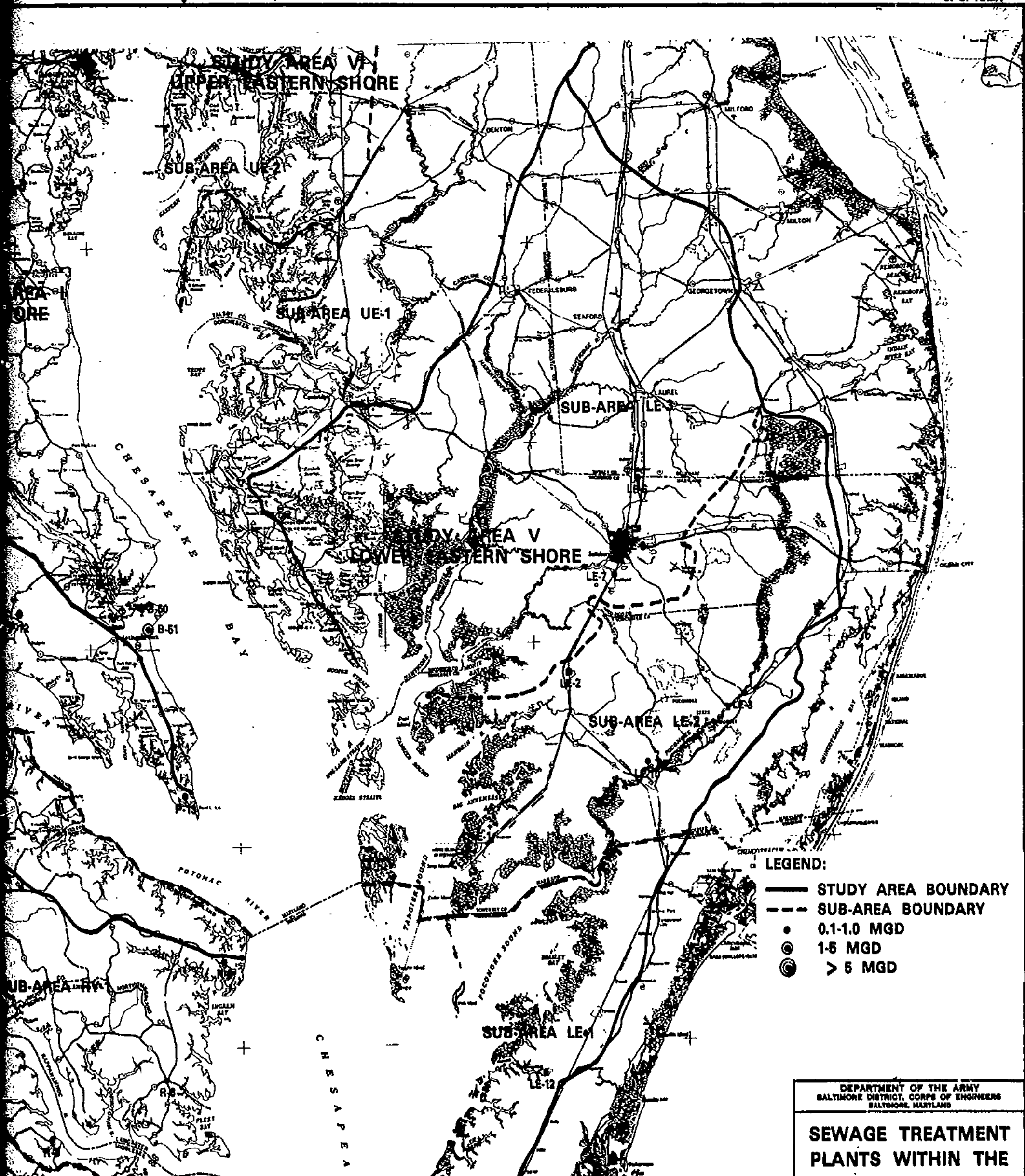
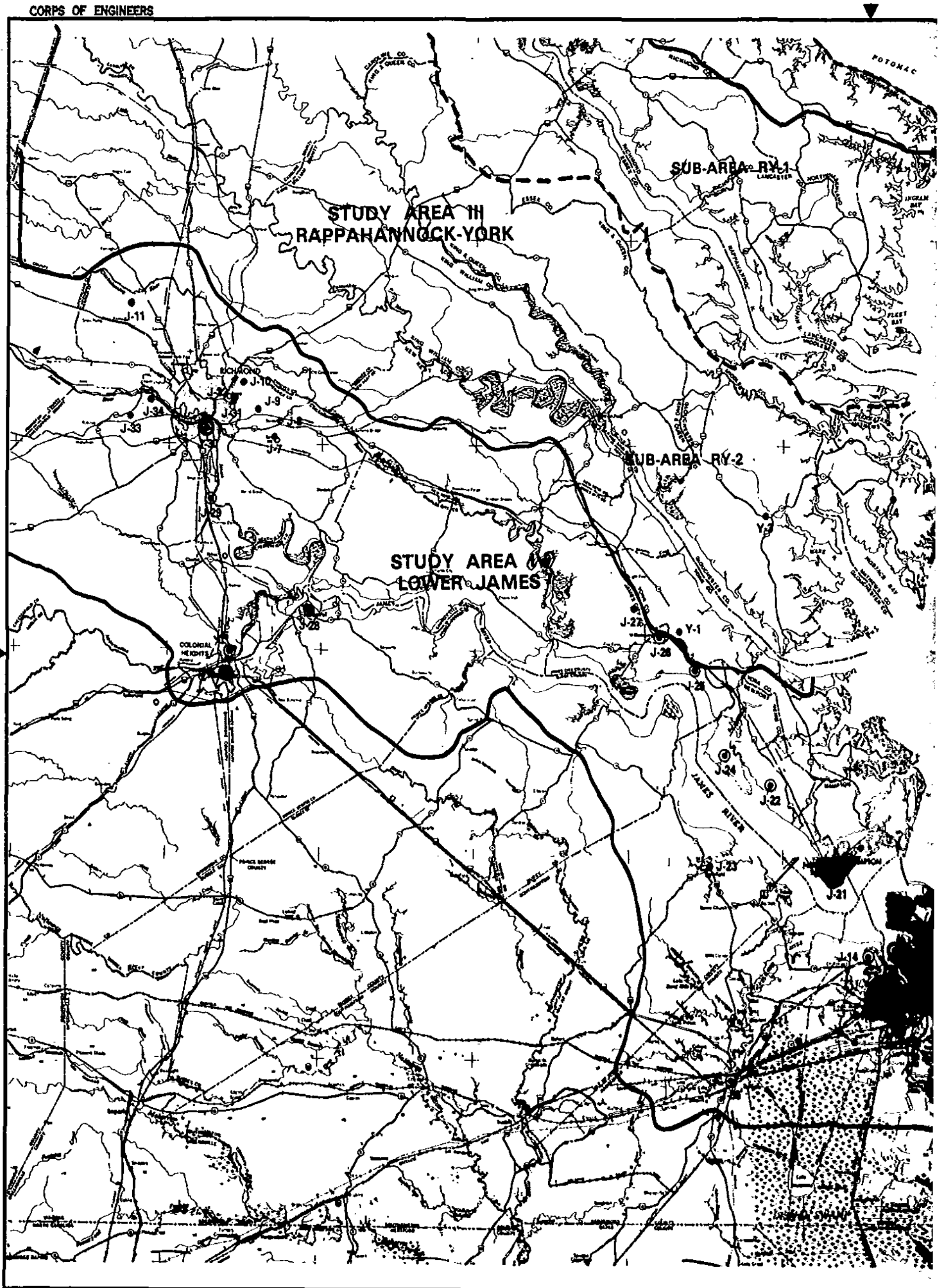


PLATE 7-2


STUDY AREA III
RAPPAHANNOCK-YORK
SUB-AREA RY-1
SUB-AREA RY-2
STUDY AREA IV
LOWER JAMES
RICHMOND
COLONIAL HEIGHTS
JAMES RIVER
POTOMAC
J-11
J-10
J-9
J-34
J-33
J-7
J-29
J-28
J-27
J-26
J-24
J-22
J-23
J-21
J-14
Y-1

U. S. ARMY

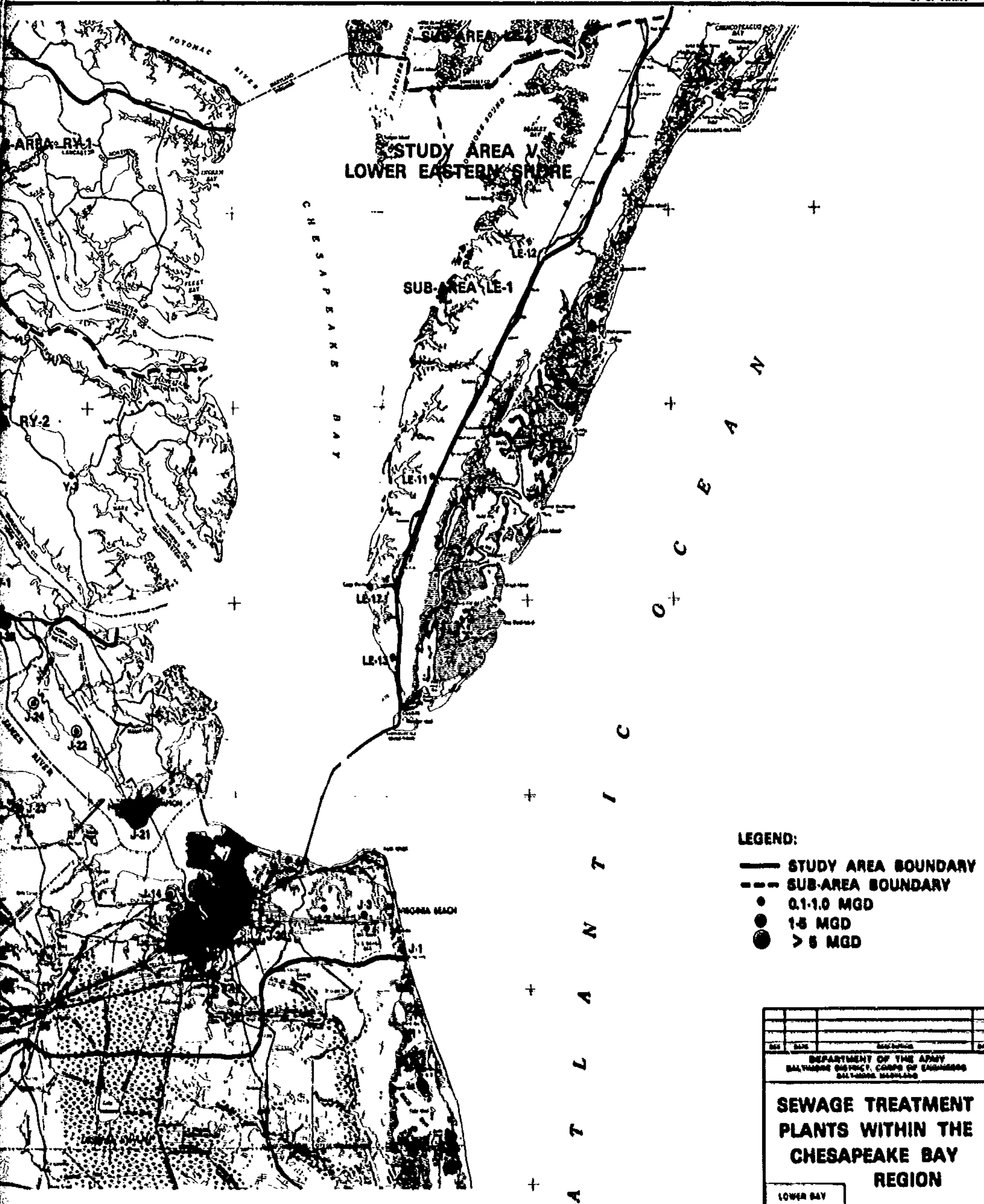


PLATE 7-3